ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Vol. XXIV. No. 28.

TABLE OF CONTENTS.

Engineering News of the Week 25, 26, 42

Technical Articles:

A Suspended Wire Rope Tramway (*Illustrated*) 26
Working of Railroads by Electricity 27
The Limitations of Steam and Electricity in Transportation 29
Growth of Traffic on the Great Lakes 30
A Rotating Dump Car (*Illustrated*) 30
A Norwegian Boiler Explosion 30
The Efficiency Record of the Westinghouse Test Freight Train 30
A Temporary Bridge Support (*Illustrated*) 32
The Sault Ste. Marie Water Power 33
Electric Lighting in the Railroad Service 39
The Russell Snow Plow, Intercolonial Ry. (*with Inset*) 40
Sharpest Curves in Use 40
Machined Car Wheels 40
The Austrian Zone System of Railway Tariff (*Illustrated*) 41
A Rail Lifting Device (*Illustrated*) 42

Personals, New Publications, Society Proceedings 33–35

Editorial Notes 36, 37
Electric Lighting for Railway Trains—Steam and Electric Motors—The *City of Paris* Accident.

Editorials:

Dams and Reservoir Embankments for American Waterworks 37
The Laws of Air Resistance 37

Correspondence 38, 39
Safe Loads for Piles—A Catenarian Problem—The Laws of Air Resistance—Notes and Queries.

Construction News 42, 46
Railways, City Transit, Highways, Bridges, Tunnels and Canals, Water-Works, Sewerage and Municipal, Electrical, Contracting, Proposals Open, Manufacturing and Technical.

BRIDGE IMPROVEMENTS AT WASHINGTON, D. C., are recommended in the report of Col. PETER C. HAINS to the Secretary of War. Long Bridge, the report says, ought to be reconstructed at once, since while it remains as it is work has to be all the time expended on the channel of the river above it. The spans of the present bridge are too short and the piers are many of them badly placed and form a serious obstruction to the current. This reconstruction has been recommended in the annual reports for the past 10 years. To delay it longer is to invite the destruction of the bridge, damage to the work on the river front and still greater damage to the city.

COL. HAINS also recommends the construction of a suspension bridge to Arlington. His designs are for a bridge of the following dimensions and type:

The clear height above the water at mid-channel to be 105 ft. The river span to be 1,100 ft. and the two shore spans 652 ft. each. The approaches at each end to be on masonry arched viaducts and embankments of earth. The suspension cables to be of steel passing over two granite towers each about 210 ft. high, pierced with arched openings for roadways and anchored into masses of masonry at the outer end of each approach. The grades to be 3 ft. per 100 on the central span, 3.5 per 100 on the shore spans and 4 ft. per 100 on the approaches. The extreme width of bridge to be about 54 ft., with a roadway for vehicles 34 ft. wide in the clear and two sidewalks for pedestrians 8 ft. each. Lateral vibration would be prevented by a system of ties extending out from the sides of the towers and vertical vibration by means of the four trusses.

The cost would be about $3,591,000. By reducing the width to 40 ft., making the roadway 24 ft. instead of 34, a reduction of about $500,000 can be made in the estimated cost. A still further reduction of about $400,000 could be made by building the approaches on iron trusses resting on masonry piers.

THE POTOMAC FLATS IMPROVEMENT, described in the same report, has thus far required the expenditure of about $1,424,000. There have been dredged from the channels of the river and from the tidal reservoir 8,301,000 cu. yds. of material, which has been deposited on the flats, raising nearly the whole 621 acres above the flow of ordinary high tides, and creating an area of magnificent park land where formerly was a pestilential marsh. Independent of the benefits to navigation or to the health of the city, the value of the land is said to be far in excess of its cost. More appropriations are urgently needed to protect the work already completed from serious injury by possible freshets.

THE WEST END R. R. BILL has been passed by the Massachusetts Legislature, authorizing the West End Co. to build 1.5 miles of double, or 3 miles of single track in Boston. Work must be completed within 2 years or the charter will be forfeited.

THE ELEVATED ROAD of the Merchants' Terminal Railway Co. in St. Louis is being rapidly erected. It will be from 14 to 22 ft. in height, built in 30 ft. spans. The total length will be 8,000 ft., giving access from the bridge terminus to the Union depot without the present disagreeable passage through a tunnel. It will be completed some time in August and then the Merchants' Bridge will be formally opened for traffic.

THE STEEL TUBULAR CAR COMPANY has been organized to erect a large plant near Bradford, McKean Co., Pa., for the manufacture of passenger cars with a steel tubular frame work. The car is the invention of JOHN W. POST, who is to be General Manager of the new company. The proposed works are adjacent to the line of the Buffalo, Rochester & Pittsburg and the New York, Lake Erie & Western Rys. The press report from which we take the above item states that $5,000,000 capital has been secured, and that in 18 months works employing 5,000 men will be in operation. These extravagant figures rather lead one to doubt the solidity of the enterprise.

THE RAILWAYS OF INDIA now have a total extent of 16,095 miles, of which 869¼ miles were opened for traffic during the last fiscal year. The important events of the past year were the opening of the Khojak tunnel and of the Damodar bridge on the Bengal-Nogpur line.

A NEW 56-LEVER INTERLOCKING MACHINE has been placed at Broad St. Station, Philadelphia, governing 4 additional tracks or 12 in all. The work was done between midnight Saturday and 2 P. M. Sunday. The old machine which controlled 8 tracks made 1,734 train movements per 24 hours. The greatest number of train movements in one hour ever made with it was 134.

ELECTRIC TRAIN LIGHTING has been practised with some degree of success on the Springfield & Northampton branch of the Connecticut River R. R., despite the rather discouraging results attained on other lines. The system employed is the invention of Mr. S. H. BARRETT and is essentially a combination of the dynamo and storage battery plans, as nearly as we can make out from the few details at hand.

A PRACTICABLE CONDUIT SYSTEM FOR ELECTRIC RAILWAYS is said to be nearly perfected by the Thomson-Houston Co. Should this prove true it will doubtless give a great stimulus to electric railway enterprises, especially in the large cities where the overhead wires and unsightly and obstructive poles have been a great obstacle in the way of the introduction of electric railways. It is hardly likely, however, that the conduit system can be made as cheap as the overhead system, even if it can be made to work as well.

THE WORST ACCIDENT of the week was a head collision, July 9, near Clear Creek, Ala., on the Louisville & Nashville R. R., between a freight and a passenger train, killing the engineer and fireman of both engines and one brakeman and seriously injuring an extra fireman. The freight train was an extra, and it is said the passenger train had orders to take the siding at Clear Creek.

ANOTHER DEFECTIVE SWITCH ACCIDENT not quite so serious as the one at Joliet reported last week, occurred at Manteno, Ill., to a special excursion train of 14 cars on the Illinois Central R. R. The train was running at about 35 miles per hour. The engine and four cars passed over the switch all right but the other cars were turned upon the siding. When the train broke, the fifth car was tipped upon its side, killing one passenger and injuring five. Press reports say that a loose bolt in the switch was shaken out by the passage of the train.

A BRIDGE ACCIDENT is reported on the Mexican National Ry. near Obregon, on June 27. A freight train went down with the bridge and three men were killed.—Eighteen spans of a highway bridge in Bossier Parish, La., fell recently.—A coal pier of the Philadelphia & Reading R. R. a Elizabeth, N. J., collapsed this week, carrying down 92 coal cars with it.

AN UNDERGROUND RAILWAY for distributing freight in St. Paul is planned by J. R. MCMURRAN, of that city, HENRY VILLARD, JOHN D. ROCKEFELLER and others. A large amount has already been spent in securing right of way and real estate.

AN AUDIBLE BLOCK SIGNAL SYSTEM was tested June 28 on the Suburban Elevated R. R., New York City, with, it is said, complete success. This signal, which is manufactured by the Desaut Electric Co., of this city, rings a bell or blows a whistle in the cab of an engine entering a block occupied by another train.

SERIOUS STORMS have occurred in the North and East. A tornado struck Fargo, Dak., July 7, killing nine persons and doing great injury to property. A Northern Pacific train of 14 cars just outside the city was blown from the track, the engine alone remaining on the rails.—A hard storm in New Jersey raised the streams and carried away two bridges at Milford and one at Fullerton, and washed out 100 ft. of the Pennsylvania R. R. tracks.—A washout occurred on the Pittsburg, Cincinnati & St. Louis near Coshocton, O., blocking traffic half a day.—On the Burlington, Cedar Rapids & Northern a 70-ft. Howe truss bridge was taken from its abutments by a flood, carried 100 ft. from the road, and landed among some trees.—Other storms are reported at Cleveland, in the vicinity of Lake Champlain, and in Maine.

A DAM at Price's Lake, between Washoe and Carson, Nev., burst on July 6. The flood poured down the cañon as a wall of water 30 ft. wide and 100 ft. high. No lives were lost.

THE MACCOMB'S DAM BRIDGE contract has been awarded to HERBERT STEWARD, whose bid was $514,423, the lowest received. A detailed list of the bids will be given next week.

A SUBMARINE TUNNEL from Staten Island to Brooklyn is said to have been planned by the fertile brain of ERASTUS WIMAN. Since the completion of the Arthur Kill bridge the Baltimore & Ohio has been delivering and receiving a vast amount of freight on Staten Island, which is said to be now the cheapest and most convenient site for transshipping cargo between vessels and cars in all New York harbor. In New York or Brooklyn freight transfer involves expenses for lighterage, truckage and delay. Recently a ship which arrived at Staten Island with a cargo consigned to Pittsburg parties was unloaded directly into the cars. It is to place the Brooklyn docks on an equality with Staten Island in this respect that the proposed tunnel is projected.

THE HARLEM SHIP CANAL is viewed with much disfavor by the residents of the annexed district and the dwellers in all the New York suburbs north of the Harlem River. Rapid transit between these points and the lower portion of Manhattan Island is certainly the great need of this section, but the obstacle of the Harlem River and the drawbridges which would have to be frequently opened if the ship canal was completed, is felt to be a great one. Really the only legitimate reason for building the canal seems to be the increased water front which would be created. If this can be secured and the canal can be operated with but little interference with the street traffic, it may be best to complete it.

A NICARAGUAN CORRESPONDENT writes us that the borings of the great divide cut are resulting very favorably indeed, the quantity of rock being much less than was expected, while yet the material is stiff enough to hold a steep slope. The health of the parties in the interior is excellent, but among the working force building the railway in from the coast there is a good deal of malarial fever, as we have before noted. Except the building of this railway, however, which will be complete in a few weeks, there is no work except dredging to be done on the coast flats. Living creatures of all kinds, venomous and non-venomous, are scarce in the forests, as are also fruits.

THE EXAMINATION OF FRUIT HILL RESERVOIR at Providence, R. I., by JAS. B. FRANCIS and City Engineer SHEDD, shows the trouble to arise from the seamy water bearing rock on which part of the walls are built. The walls at the upper portions of the reservoir are in excellent condition. At the lower portion, where they are underlaid by the defective ledge, they will probably have to be torn down and rebuilt, the seamy rock being repaired to make it water-tight.

A LARGE IRRIGATING ENTERPRISE is under way in India on the Periar River. A concrete dam 155 ft. in height is to be built directly across the river, forming a storage reservoir about 10 sq. miles in extent. The water thus stored is desired for use in the district of Madura, which lies in an adjoining water shed. The storage reservoir is, of course, very irregular in shape, and one long narrow bay reaches within a short distance of the height of land which separates the Periar from the Madura watershed. Here a canal will be excavated as far as possible and then a tunnel 5,700 ft. in length will be driven emerging on the other side in the Madura basin down which portions of it will be carried 90 to 100 miles before it is used.

Work cannot be carried on during the summer months, but the season just closed has witnessed good progress on the preliminary works. The site of the dam is now inclosed by masonry walls forming the front and rear face of the dam, 7 ft. above the river bed in front and 20 ft. in the rear. A by-pass has been formed on one side to discharge the water of the river while construction is in progress. The dam will have a waste weir on each side. One of these is well advanced. The stone from these and from the tunnel will be used in constructing the dam. About 435 ft. has been excavated on the tunnel. Air drills are used, the compressor being driven by a turbine. The canal up to the tunnel is about half completed. When finished boats will be placed on it to transport the stone to the site of the dam.

THE "CUCUMBER FLAVOR" is troubling the waterworks superintendents in several Connecticut towns. The new reservoir at Wilton, from which the city of South Norwalk draws its supply, is affected in this way, and it is proposed to try the experiment of stocking the reservoir with German carp. These fish are vegetable feeders and it is hoped that they will keep the reservoir clear of all plant growths and especially of the *spongilla* which causes the trouble. It is suggested, however, that possibly these fish may cause a worse trouble than the one they are to be introduced to remedy. It is their habit to continually stir up the mud of the bottom and banks in their search for food. In this way, in a shallow pond with a clay bottom, they are apt to keep the water roily.

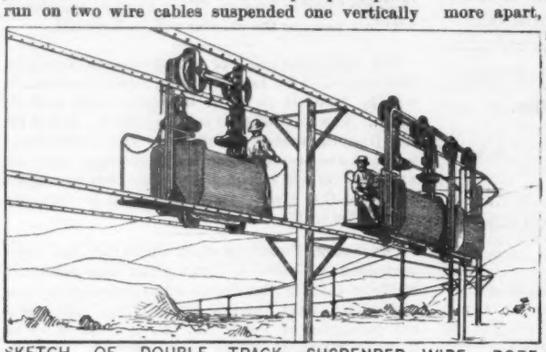
THE NEW SEWAGE DISPOSAL WORKS at Worcester, Mass., were put in operation on July 2. The precipitation tanks cover nearly an acre and are built of brick. The total appropriation for the plant was $135,000, not all of which has yet been expended The annual expense of the chemicals, labor, etc. used in operating the plant is expected to be about $20,000. We hope soon to give a full description of these works.

THE NEW YORK STEAM HEATING CO. has been ordered by the Board of Health to shut off steam from three sections of its Broadway main, and the greater part of its Wall St. main, on the ground that the mains are a public nuisance, and dangerous to life and health. The report of the Board to Mayor GRANT states that the temperature of sewers in streets where the steam-heating mains are laid has been found to be greater than in streets where no steam pipes are laid. Besides this the vaults, sidewalks, and gas and water supply are all found to be more or less affected by the steam pipes. This is due partly to direct radiation, and partly to escaping steam. The report says, "It is safe to assert that every joint in the mains in Broadway, south of Reade St., permits the escape of steam into the earth."

Tests with the thermometer showed that the temperature in some manholes ranged from 140° to 162°. Water in the Croton pipes near the steam pipes was found to be heated to 120° at points where it ran into buildings. In vaults under Broadway buildings the air had been heated to 140°.

A Suspended Wire Rope Tramway.

The idea recently broached by a contemporary journal* of a vehicle built on the bicycle principle to run on two wire cables suspended one vertically over the other and said to be the suggestion of Dr. G. P. HACHENBERG, of Austin, Tex., is by no means new. A similar system of electric wire transportation has been for several years carefully worked out by the Suspension Transportation Co., Col. WILLIAM L CANDLER, President, with offices at the Equitable Building, Boston, Mass. It is the invention of A. D. CHANDLER.



SKETCH OF DOUBLE TRACK SUSPENDED WIRE ROPE TRAMWAY

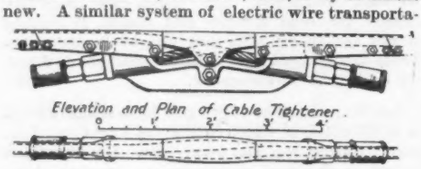


Fig. 1.

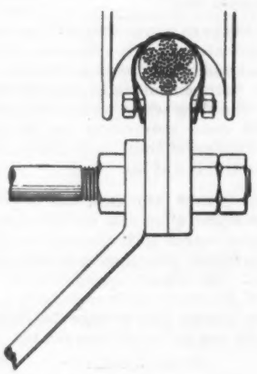


Fig. 2.

The illustrations show the plan. The application of the principle is made to freight carriage where only about one or two tons net weight of freight is to be moved at a time. The system consists of two stationary steel cables, suspended one above the other between posts of wood or metal, 50 ft. or more apart, and at such an elevation from the ground as not to interfere with surface traffic. The cars are suspended by wheels between the two cables, the upper cable carrying most of the weight. The lower wheels are held to the cable by springs in such a manner that any difference of slack between the cables is taken up by the springs.

The upper cable is of steel, with a wire center, is 2 ins. in diameter, and has a breaking strain of 175 tons. The lower cable is 1⅝ ins. in diameter, with a breaking strain of 87 tons. Total breaking strain, 262 tons. On ordinary lines not over 4 or 5 tons weight comes at any one time on a span of 40 ft., and the strain on the cables would not exceed 40 or 50 tons. The factor of safety is therefore five.

The cables are held firmly in position by anchorages and brackets at the posts. The deflection of the cables depends upon their tension, and on spans of 40 ft. and a load of 5 tons is about 5 ins.

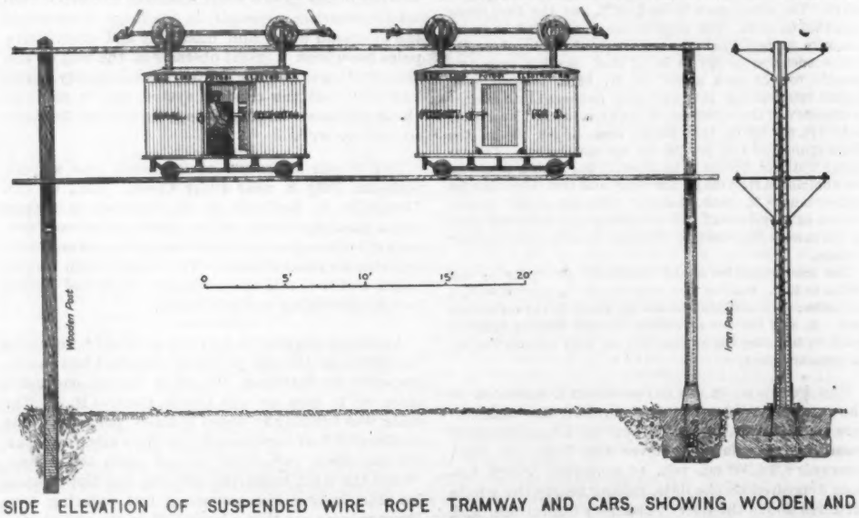
Switching is effected by a simple arrangement and either angles or curves may be turned by special constructions.

For use in a mining country where it is impracticable to transport a long length of cable, and splicing is difficult, the arrangement shown in Fig. 1, is employed to avoid splicing. The ends of the cables are crossed and held by tightening clamps. The wheel grooves are sufficiently large to allow the car to readily pass at such points, over the crossed cables. The cables are not in motion or bent upon a drum an l are used only to sustain the weight. Of course the main cost of this system is that of the cables. To obviate wear they are covered with a metallic cap, as shown in Fig. 2. This cap is of steel, about ⅛-ins. thick, and gives a perfectly smooth surface for traffic. They are put on in lengths which overlay at the ends and are riveted together. This saves the cables from abrasion, economizes power, lessens running expenses, increases traction and strengthens the cables.

The rolling stock consists of cars with or without motors attached. The lines may be operated by electric motors or by gravity, and the design of cars and line is adapted to the location and requirements of the special service for which it is employed. The cars may be run singly or in trains.

An application of the system, for which full working plants have been prepared, is for transportation across rivers, as between the large mills at Manchester, Lowell, Lawrence, and in other places. Also it may be employed by railroad companies to facilitate the handling of baggage.

Its application has been suggested to the postal authorities for the transportation of the mails between the post office and the various railroad stations of cities. This system has the merit of offering practically no obstruction in the street, for,



SIDE ELEVATION OF SUSPENDED WIRE ROPE TRAMWAY AND CARS, SHOWING WOODEN AND IRON POSTS.

Electrical Review, Jan. 4, 1890.

except when the car is passing, the cables present scarcely more obstruction than an electric wire.

The following table shows the horse power required to move a gross ton (2,240 lbs.) of coal on grades up to 550 ft. per mile. It was prepared in connection with a coal line with a capacity of delivering 200 tons of coal per day, using two cars, running alternately with motors attached to each, at a speed of 6.82 miles per hour. The length of line is 800 ft.

WEIGHT OF LOAD TO BE HAULED, 2,240 LBS.

Grade in feet per mile.	*Total weight of loaded car.*	*Motor horse power.*
0	5,000	0.5
50	5,000	1.5
100	5,000	2.5
200	5,170	4.25
300	5,370	6.5
550	5,370	11.5

Working of Railroads by Electricity.*

It is asserted that the day is not far distant when we will see railroads, generally known as steam lines, run by electricity from a central station. This is, doubtless, not the first time such an assertion has been made; but I have not as yet seen any discussion of the subject which has more than insinuated the advantages which would result in the operation of railroad lines by such a concentration of power. From a lack of time no attempt is made to analyze the two methods in a mathematical way, but rather it is aimed to point out some of the many advantages which the use of electricity allows, and which will inevitably result in operating a long line.

With this object let us take a few of the changes which the substitution of centralized electricity would inaugurate when used in place of the present system of locomotives.

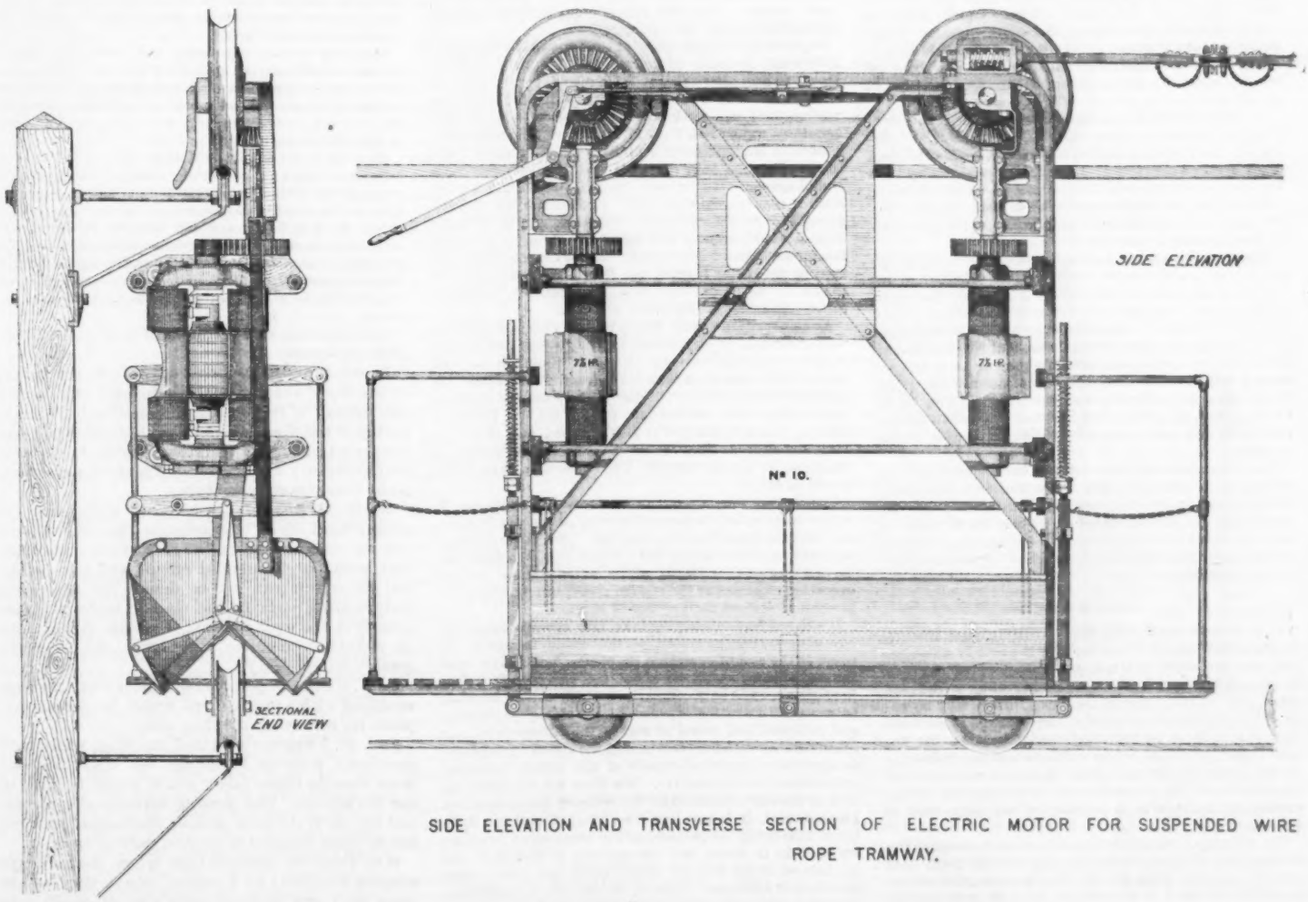
One very important gain would be the concentration of the power at one point, for a given length of line, into a few cylinders, instead of working it in a number of isolated engines where the insulation is poor and the chances for condensation the best. A number of central stations—located, say, at a distance of 30 to 40 miles apart—could be run by large, powerful engines, and the expansion of the steam worked at an economical point by better and more mechanical means of cut-off than can be obtained in the present type of locomotive construction. With locomotives the ratio of expansion at low speeds is correspondingly poor, nor can we expect to make an efficient engine of it, except in one working condition which is dependent upon the concurrence of so many variables that the engine is never worked in that ratio for any length of time. With stationary engines, however, the case is the reverse, as these are designed to work at a constant speed, and if properly proportioned would be utilized at the high est grade of expansion consistent with economy. This point would not vary much, as experience with hydraulic and electric plants would indicate. The fluctuations in the case of a railroad line would brobably be even less, as the working is generally uniform throughout the twenty-four hours of the day. It would be a case of a properly loaded automatic cut-off engine against the equivalent of a similar engine vacillating between an over to an under load, and such range of the broadest nature. We must not lose sight of the fact that the question of keeping the line clear is properly held as of higher value in a closely worked system than is the consumption of coal which may result per the horse-power, which the engine is to develop to reach its destination as scheduled.

In furtherance of a reduction in coal consumption, the use of condensing—and possibly compounding—at a central station would raise this part of the working of the line to the highest grade of efficiency.

In experiments recently made it was found that an electric motor could climb a grade of over 50%, which is far beyond the point of adhesion of locomotives; so that in this direction we could look for a marked improvement. An analysis of the conditions in the two cases will disclose the reason for this, and no doubt all who have had any experience with engines which were overloaded or which slipped their drivers easily will appreciate its importance.

The question of attainable speed enters as a factor, for the speed to which an engine can safely be driven is known to have its limits—and which, to all appearances, we are now closely approaching. The piston speed of an engine with 24 ins. stroke and 68 ins. diameter of driving wheels, traveling at 60 miles per hour, would be about 1,400 ft. per minute. An increase in the diameter of driving wheels, with the object of decreasing the number of strokes, makes the engine correspondingly weaker, so that two sharp horns of a dilemma are placed before him who attempts to design an engine to haul the increasing weight of trains at a high speed. The questions of ports and velocity of steam are mentioned in passing. The resistance of trains is now quite positively known to increase about with the square of the velocity which would enter as a function in the power to be given to a motor to drive a train at a desired speed. With such a means, however, the speed is limited only by the power which is given in its design, and is determined more by what the conditions of the service will stand.

With electric motors it would not be necessary to have track-tanks and water stand-pipes distributed closely throughout the line, which means considerable to those who are acquainted with the attention and repairs (especially through the winter season) which such arrangements demand. The delay, too, where freight engines are not equipped with water scoops, is apparent; and even this latter method of filling tanks is beginning to show its effects upon the schedule, which it is possible to make on lines which are worked closely to their limit. Nor would it be necessary to carry the dead weight of tender which contained water, which is hardly as easy an accompaniment as its name would imply. In this connection it might be well to mention the annoy-



SIDE ELEVATION AND TRANSVERSE SECTION OF ELECTRIC MOTOR FOR SUSPENDED WIRE ROPE TRAMWAY.

ances from cleaning fires, as is required in freight service where the division is a long one.

The experience with the centralization of power where large hydraulic, electric or pneumatic plants are in operation, is that a greater amount can be supplied than it is necessary to develop at the station—that is, where there is much division (such as would be the case when the power is distributed through commercial districts and divided into small parts) a 50 to 60 H. P. plant can take and supply satisfactorily about 100 H. P. In railroad work such a ratio could hardly be looked for, as the number of trains would not be as large as the division where the power is distributed for mercantile and commercial purposes; but a reduction of some 25% can safely be counted upon. The reason for this is evident, as it never occurs that all the power will be used simultaneously which each division is capable of exerting. With railroads, too, it will not occur that all trains would be exerting their maximum power, such as, for instance, climbing heavy grades at the same time.

The best kind of mechanical ingenuity and high efficiency of any mechanical design which is made to accomplish a given object are dependent, principally, upon re-

* A paper by WILLIS E. HALL, Altoona, Pa., read at the Cincinnati Meeting of the American Society of Mechanical Engineers.

ducing the number of parts which it contains, so long as the desired result is obtained. Multiplication of parts increases the number of pieces to wear and consequent repairs, as well as the chances of failure from breakage. No argument is necessary to indicate the advantage which electric motors would have over the present design, or over any other design of locomotive where all the requisites of an engine must be incorporated in so many isolated places. The failures from leaky flues, broken eccentric strap knocking a hole in the fire-box, blowing or knocking out cylinder heads, and the multitude of accidents which are happening every day on railroad lines, would be decreased to a marked extent. The reduction in the internal friction of the driving mechanism is also apparent.

No comparative mention has been made of the cost of repairs, the too large percentage of power which is idle to have this work done, the reduction in the number of motors required to make the same train mileage (due to more uniform and consequent higher average speed, resulting in a reduction of time to go over a length of line), together with the loss of coal from irregular working of engine and boiler where the line is undulating, as is the case with all to a greater or less extent; also the attention and care which a large number of isolated boilers demand to keep them in a safe working condition, as well as the rapid wear of machinery where it is exposed to out-door influences, such as dirt and the elements, as is the case with locomotives. In fact, the elimination of such details could be extended almost indefinitely, and in them there would appear visions of a removal of a mass of the little annoyances from the shoulders of those who are now held responsible for the maintenance of this accumulation of complications.

The loss in electric transmission has not been neglected, which in a station controlling a line of, say, 30 miles would, at the present state of the science, amount to some 50 per cent.—which includes loss in dynamo, line and the loss from an average working of motor. This, together with the cost of necessary plant as capital, comprise the two main objections against the introduction of electricity for transportation purposes.

No attempt is made to take up the advantages or disadvantages (as shown by mathematical calculation) resulting from such a system, but it is merely desired to mention some of the many practical points which would be met, eliminated or improved upon by the substitution of electricity in general railroad working. Nor is it that its introduction is anticipated within a year or two; but we cannot but acknowledge that the application of electricity is becoming more general, and, from the rapidity of its development, its use for such purposes is hardly more distant than the most sanguine of its advocates would predict.

The combination of electrical with mechanical engineering will bring about as much of a revolution in the future as it has done in the past; but in all its applications we must expect to see it creep before we may see it walk. A more thorough intermingling of the mechanical, however, would hardly be a detriment to much of the so-called electrical engineering.

DISCUSSION.

F. A. SCHEFFLER (Acting Supt. Westinghouse Electric Company's Works): In reading over the article which has just been presented by Mr. HALL, I am tempted to give a few points in regard to the cost of installing a railroad plant, such as the author of the paper thinks will be required in the near future, and at the same time I desire to state that it is to be regretted that Mr. HALL did not spend some little time, before writing his paper, in looking up the matter of electrical data as far as railroads are concerned, and the necessary cost of installation of the generating stations at a distance of not more than 30 miles apart.

The ordinary locomotive of to-day, when running at the average rate of speed and hauling the average load, does work of not less than 300 H. P. Supposing the station to be built to have a capacity to each 30 mile section of not more than one locomotive, the capacity of the generating station would necessarily have to be not less than 360 H. P. As the best forms of motors at present have an efficiency of only about 80 to 85%, it will require, therefore, for the generating station a 360 H. P. engine and sufficient boilers for operating same. The cost of the station can be summed up about as follows:

One 360 H. P. engine	$10,000
Battery, A 1, of 360 H. P. boilers	7,000
Station building	5,000
Steam connections, pumps, feed-water heaters, etc.	2,000
Generating dynamo	12,000
Electrical station, appliances, etc	1,000
Making a total of	$37,000

The foregoing station outfit will not permit of having an auxiliary plant of engine, dynamos and boilers, which ought really to be included in the outfit, so that in case the engine or dynamos or boilers should, at any time, become inoperative, there would be another set of appliances to operate the railroad with. An auxiliary set of appliances would almost double the total cost of the station.

For operating expenses of the station we have the following:

	Per year.
5% depreciation on engine and boilers	$835
4% " " dynamo	480
6% interest on the station plant	2,220
2 firemen, night and day	1,440
2 engineers, " " "	1,080
Maintenance, such as oil, waste, etc	300
Making a total of, not including the cost of coal	$8,355

In order to ascertain what the cost of coal would be, we will suppose that the total power is required for only one-half the time, and one-quarter the power for the balance. This will give us 2,774 tons of coal, per year, required. This assumption is based on the supposition that the engine will require 3 lbs. of coal per H. P. hour; if it were a condensing engine, of course the assumed rate of coal per H. P. would be too high, but I should not think it would be advisable to use a condensing engine where the power would be so largely variable, and water along railroad lines is not always available for condensing purposes. Basing the cost of coal at $3 per net ton, the expense per year for same will be $8,322; adding this to the operating expenses of the plant at the station, we have a total of $16,677.

So far, we have only taken into consideration the necessary cost of operating expenses of the station plant. We have now to consider the erection of the necessary electrical circuits along the line, the depreciation of same, and interest on the cost of same.

Suppose that the pressure at the terminals was fixed at 2,000 volts, in order to deliver 3 H. P. to the motor, it would be necessary to carry 112 ampères on the line, and allowing 20% drop in the pressure, by simple calculation, we find that the conductor will have to be of an area equal to a copper rod, 1 in. in diameter. The pressure of 2,000 volts is altogether too high to think of safely using the rails for the return circuit, and a copper conductor would also have to be used for this circuit, making two lines of copper conductors, 1 in. in diameter for the outgoing and return circuits. If the circuit is 30 miles long, it would require the enormous quantity of 476,784 lbs. for each conductor; and the cost for copper wire at the present time being 17 cents per lb., the amount required to pay for the copper wire would be $162,106. The interest on this outlay, at 6%, would be $9,726.

As an overhead circuit would be the cheapest possible way of conveying the current to the motor, and as the wire is of such an enormous weight, it would not be well to have the poles more than 50 ft. apart. This would require 6,300 poles. Basing the cost of the poles and erecting same at $2.50 each, we have the total of $15,750. Erecting the line would be charged at $150 per mile, and this is a very low figure. This would give us $4,500, making a total cost for the line $20,250. The interest on this, at 6%, would be $1,215.

Continuing the statement of operating expenses, it would be necessary to add the interest just given to same, and also the depreciation of the line. Putting this latter at about 2% (which is very low), which would be $3,627, we have a sum total of $31,245 as the actual annual cost of operating expenses of the station plant, and interest, depreciation, etc., on each section of 30 miles.

It will not be necessary to take into consideration the cost of operating the motor, as this would be about the same as the cost of operating the steam locomotive; and the cost of same would be about the cost of a first-class locomotive. The only comparison which should be made between the operating expenses of the steam locomotive and the electrical, would be that of the difference in coal consumed between the station, and the steam locomotive, and possibly the cost of repairs of the motor, compared with that of the locomotive. We have not the exact figures of the coal consumed by the ordinary locomotive, but I do not think it is any less than 8 lbs. of coal per H. P. hour. This being the case, and as the locomotive develops 300 H. P. for 12 hours, and one-quarter of this H. P. for the balance of the day, we would have, per year, a consumption of 6,570 tons. This, at $3 per ton, is equivalent to $18,710. Deducting the same from the total operating expenses of the electrical station, we find that the difference is in favor of the steam locomotive to the extent of $12,475 per year. I do not think there would be any difference in cost of repairs between the electrical and the steam locomotive. The total cost of the station, copper wire, and poles and line, complete, would be $219,356. This amount of money would buy about twenty new locomotives.

The foregoing estimates are all based on inside figures, and if the railroad were 600 miles long, it can be readily seen what an enormous expenditure for electrical purposes would be necessary, and comparing this with the cost of the present steam railroad would be sufficient to upset any calculation in the line of electrical railroads.

I have selected an average of $2,000 as a basis for estimating the cost of line, simply because it would require *extraordinary care* in insulation for a higher potential where the bare conductors, connections, insulating material, etc., would be subjected to all kinds of rough weather. If it were found that 4,000 volts could be satisfactorily insulated (and this has been done with covered wires in a few special cases), the first cost of line equipment would be very largely reduced to, say, about one-half of the above estimated cost, thereby reducing the yearly expenses of operating by decreasing the interest and depreciation of the plant. As far as safety to human life is concerned, I do not believe that 4,000 volts would annihilate more completely than 2,000; but the chances for leakage of current at the higher tension would be much greater. This would mean greater coal consumption and reduced efficiency of the electrical apparatus. The operation of the plant at the full power for one half the time involves, of course, the use of several motors, which has not been considered in the matter of operating expenses. Such considerations would not make any difference in cost of operating expenses, because there would necessarily be the same amount of expense in the line of engineers, firemen and depreciation, etc., for the locomotives, as there would be for an equivalent number of motors.

A statement made by Mr. HALL is as follows: "In experiments recently made, it was found that an electrical motor could climb a grade of over 50%, which is far beyond the point of adhesion of locomotives." I would like very much to make an inquiry as to the facts of these statements; it would be very interesting to the members to learn what motor it was, and how long the grade was, and what the speed was attained. It is well known, of course, that there is some very peculiar action between the tread of the wheels of electrical street cars and tracks, whereby they can ascend a higher grade than any other kind of motor power, except the cable system; but I am very loth to believe that an electric motor can ascend a grade of over 50%.

It is safe to say, that unless there are some radical changes made from the ordinary design of electric generators, and in the method of the transmission of the current to the motor, as well as a motor of greater efficiency; that we will never see electric railroads operated in this, or any other country.

ARTHUR T. WOODS: The author states that "the resistance of trains is now quite positively known to increase about with the square of the velocity." Reports of tests in this country and abroad, as for example, tests of the C., B. & Q. R. R., and the recently published indicator cards from a Worsdell compound locomotive taken at speeds as high as 86 miles per hour, show that the train resistance not only does not increase as the square of the velocity, but is in some cases less at high than at low speeds.

The following is a condensation of other discussions presented:

President OBERLIN SMITH advocated very strongly the use of a motor attached to each axle on each car, instead of an "electric locomotive." With the saving of the dead weight and friction of the locomotive which would thus be possible, he believed that electricity would eventually show a great economy over steam locomotion.

Mr. H. C. SPALDING said that while with the present methods of transmission the use of electricity for running long railways was out of the question, with a high potential circuit and a low potential motor it might yet be done. The absence of reciprocating parts in the electric motor will save greatly in the wear and tear of tracks. Again, with an electric locomotive the higher the speed the greater the efficiency.

C. W. BARNABY pointed out that if every car were equipped with a motor there would be greater expense for cars lying idle than now.

JNO. M. SWEENEY said that one thing which gave electricity such an advantage for street railway work was the cheap labor which could be used to run the motors. The gearing between the motors and the car is the most serious mechanical problem before those engaged in electric railway work.

WM. FORSYTH declared that when the railways adopted electricity as a motive power they would make their own machinery at a cost of one-half to one-fourth of what the electric companies are now charging. The first use of electricity on railways will probably be for running heavy switching motors.

The discussion was further carried on by Messrs. ROGERS, DASHIELL, MEBBEY, MORGAN, SMITH and others.

Since the close of the meeting Mr. F. A. SCHEFFLER has submitted the following further discussion:

I desire to correct what seems to be the prevailing opinion of some of our friends who have partaken in the foregoing discussion of my comments on Mr. HALL's paper, in that my statements were with a view of creating a feeling that I am not in favor of electrical railways of any kind. I most emphatically desire to say that an opinion of this kind is entirely inconsistent with the statements I have made. I am particularly desirous of furthering any matter which pertains to the advancement and introduction of electrical work of all kinds, as there is no branch of the world's industry which is or will not be influenced by the electrical industry. Careful perusal of my discussion will

show that in no case have I ever hinted that I am desirous of crying down electric railroads, and I am extremely disappointed to learn that certain members did not give as careful attention to my remarks as I should certainly have desired.

My object in presenting the comments was explicitly stated in the first paragraph of same, and in endeavoring to show what the cost of installing and operating one section only of such a railroad as Mr. Hall has suggested, I fail to find anything which would give rise to the opinion that I am personally against progress in this line. I, too, desire to see electricity supplant the present steam railroad, but *at present* cannot see exactly how this can be accomplished from a commercial standpoint. In this respect I concluded my remarks with the suggestion that it would be necessary to make a considerable advancement in the line of a better and cheaper generator, motor, and method of transmitting the current from the generator to the motor. Does this statement even suggest that I am not in favor of electric railway work?

If as much progress is made in the next ten years as has been achieved in the past decade, there will be more of a possibility of our capitalists adopting electricity in place of steam on railroads.

Three different members have asserted that I have estimated too high by 50% in three different items. I do not desire that my figures shall be taken as absolutely correct, but I would like to have a comparison of cost by parties who are familiar with electrical and mechanical estimates, from a conscientious point, made upon the same basis which I have estimated. I shall be happy to acknowledge any errors which I may have made, and will be only too glad to cut down the apparently enormous first cost of even one section of the suggested railway plant.

A specially devised method of feeders would possibly reduce the cost of the copper circuit, but at present I do not see wherein even this could be accomplished, unless, perhaps, a 3-wire system should be used, but which would involve a further complication of carriers, etc. One thing certain is that to carry 300 H. P. at 2,000 volts, with 20% drop, requires the same amount of copper for conductors, whether the latter be composed of one or is sub-divided. I have taken as a basis the lowest possible generating capacity, and an increase of this simply means additional first cost, and some of our heavy locomotives surely develop a much higher amount of power at certain times than 800 H. P. I have also estimated upon only one motor being in operation on the 30 mile section, whereas it would not be a very paying road which would operate under such a condition. More than one motor upon the section at the same time involves a still further increase of generating plant and conductors.

I have only presented these latter considerations to show that I do not think my estimate too high.

The Limitations of Steam and Electricity in Transportation.

As noted in ENGINEERING NEWS of May 24, the preceding paper and discussion which followed excited more general interest than any other paper presented at the Cincinnati Convention of the American Society of Mechanical Engineers. At the Convention of the American Institute of Electrical Engineers, held at Boston the following week, another paper on this topic was read by Mr. D. P. CROSBY, of the Weems Electric Ry. Co., whose interesting paper on air resistance was published in our issues of May 31, June 7 and June 14. Mr. CROSBY'S paper was entitled "The Limitations of Steam and Electricity in Transportation," and was largely devoted to the possibilites in the use of these two motors for propelling cars at exceptionally high velocities. The discussion was largely mathematical, and it was accompanied by extended tables. Our space allows the reprinting of only a part of Mr. CROSBY'S argument and his final conclusions as follows:

"Do you expect electric engines entirely to displace steam locomotives on all railroads?" That is a question which has doubtless been propounded to many electrical engineers. Its answer has probably been made, in general, by wise reference to the boundless possibilities of direct production of electrical energy from heat, and to Bellamy's "Looking Backward" storage batteries.

To make some study of the boundary line dividing the province of steam locomotion from that of electric locomotion—under existing conditions of producing electric energy—is the object of this paper.

In the light of present achievements I may state, without argument, the following propositions:

First—It is possible to construct motors capable of doing the maximum work required to-day in transportation.

Second—It is possible continuously to generate electric energy equal to the capacity of any number of such motors.

Third—At any desired loss and over any desired distance it is possible to supply, by the running contact method, the necessary current, at considerable pressure, for the working of such motors.

Should there still be question in the minds of any as to the value of the running contact method at speeds much higher than those commonly used, I may state that I have seen 75 ampères at 500 volts thus continuously supplied to a car moving at more than 110 miles per hour.

These premises being established, further discussion divides itself into three parts.

First, the mere possibility, without reference to economy of steam and electric propulsion under given conditions.

Second, as to the relative cost of exerting, in a locomotive, any unit of power by electric, as compared with direct steam motors.

Third, as to the relative amount of power required by the two agents to transport a given paying load under given conditions.

In using the word steam, as above, I have in mind only the direct application of steam power on the tracks. The case of cable propulsion is not here compared, as that has within its restricted field of application, already been compared with horse, steam and electric power.

The limiting possibilities of locomotion may be understood by considering a prolongation of the lines of present practice in the direction: first, of loads handled; second, grades climbed; third, speeds attained; fourth, length of continuous runs.

Since the effect of the grade, as compared with line, is simply to increase the tractive effort required for a given load and speed, it need not be separately treated except that there has been some question of increase of adhesion, in the ground return method, which in extreme cases might appear as an advantage for electric propulsion. The matter is not of great importance, and I will refer to it only so far as to say that interpreting my own general experience and some special tests, the adhesion coefficient seems not increased in any practical degree by the mere passage of the current from wheel to rail.

The capacity of an electric engine, like that of a steam engine, to haul any given load, will be measured by the tractive effort possible to be produced and the relation between weight and adhesion for given track conditions. The ready multiplication of cylinders in the one case and armatures in the other, while maintaining mechanical unity as to drawbar division and the ready coupling of distinct locomotive units, renders the whole question of capacity to exert a given horizontal effort, without regard to the time element, unimportant and indefinite.* It goes without saying that, if desired, a single armature may be constructed capable of exerting as great a drawbar strain as any locomotive now in use.

As to limiting speeds, it is not easy to-day to make "an educated guess" either for steam or electric propulsion. The high figures for steam that have been recently presented, both from England and America, are higher than the limiting figures as they would have been given by many competent authorities only a few years ago. Eighty-six miles per hour in England, on the Northeastern Railway, 87 miles per hour in this country on the Reading Railway, have both been reported since Jan. 1, 1890. These runs are noteworthy, not only for the fact of unusual speed, but because, as shown by indicator cards in the English case, and as may be deduced from the consideration of the maximum cylinder power in the American case, the train resistances are far below the values that would have been predicted by even the most liberal of the received formulæ on the subject. The total resistance per ton, as per indicator card in the 86-mile run, was only 13.4 pounds. According to SEARLE'S formula, adopted by WELLINGTON, it should be 69 pounds, engine and tender being taken at 50 tons. The load of 347 tons was carried 86 miles per hour by an expenditure of 1,068 h. p.—this on a level. The engine was compound.

Would it be possible to attain a speed twice as great, or say 150 miles per hour?

A driver 24 ft. in circumference would require to revolve 550 times per minute in order to travel 13,200 ft. per minute, or 150 miles per hour—this without slip. Since in the case considered the revolutions per minute reached 309, and since in the Reading case a much higher rate must have been reached, the drivers being smaller, and since on stationary engines a speed much above 550 revolutions per minute has been attained, it seems beyond question that from this point of view the supposed case is quite possible.

Considering the matter of steam supply, we are again brought to consider the whole matter of train resistances at all speeds.

Total resistance to motion should be sharply divided into two classes: the resistance due to motion through air, and that due to friction and blows between vehicle and track and to friction and blows between parts of the vehicle.

For the most part those who constructed the formulæ now found in text-books, worked on roadbeds far inferior to the best work of to-day, at speeds much less than those now attained and with wrong values for at least one of the specics of resistance, the atmospheric. On this point I have recently been able to present as the results of experiments at high velocities, made by Mr. BENJ. J. DASHIELL, Jr., and myself, a formula showing the pressure to be a function of the first instead of the second power of the velocity as ordinarily assumed. A convenient datum point may be given stating that at 100 miles per hour the pressure on one square foot, normal to the direction of motion, is 13 lbs., while proper shaping of the front may reduce this 6.5 lbs.

The absolute values given, while corresponding quite closely with those of received formulæ in the neighborhood of the velocities heretofore experimentally attained, depart widely from those assumed for velocities higher than 30 miles per hour, and calculated by the quadratic relation between velocity and pressure. Using the more trustworthy values, I have been enabled to separate more nearly than has heretofore been possible the atmospheric from all other resistances met at high velocities. Some inaccuracy still remains, by reason of the difficulty of obtaining exact measure of the resting areas in a train, but I have been able, by study of careful tests made by others on the N. Y. Central and on English roads, to find that over the range from about 40 up to 80 miles per hour the tonnage coefficient seems practically constant at 8 pounds. This, of course, applies only to first-class roadbed and rolling stock. Whether this coefficient remains constant at higher speeds we do not know. There is no reason to assume, as has often been done, that it increases with the square of the velocity, and on the other hand it will not be safe to assume constancy. From experiments made with a single 2.5 tons car at about 100 miles per hour the tonnage resistance at that speed seems to be about 20 pounds per ton. Though this value seems quite high as compared with the eight pounds at 85 miles per hour, the difference is in large part to be explained by the poor condition of the track used for the experiment and a constant curvature which would call for about four pounds per ton. Until better evidence can be had it will be safe, at least, to assume a value of 20 pounds per ton, on a first class track, with good rolling stock, at 125 to 150 miles per hour.

Having made this necessary digression, we may return to the matter of steam supply, and state that by reducing weight and area, both to something less than one-half the original values in the 86-mile run, the same effort would produce the speed 150, instead of 86. The area cannot be thus reduced, but by assuming a greater reduction in weight—say to 100 tons, or to little more than engine and tender—maintenance of the higher speed becomes possible, with nearly the same steam expenditure as in the recorded case.

To attain that speed, from rest, might require such original weight of fuel and such length of favorable track as to make the feat practically impossible with steam. This leads us to inquire into the dead weight necessary for hauling say one ton at different speeds.

The author closes with the following general conclusions:

1. A slow-speed armature placed on the car axle would place the electric motor in the lead at all service speeds.

2. For speeds above 70 miles per hour an electric motor of 90 per cent. efficiency, working through gearing of 90 per cent. efficiency, would prove more economical than the steam locomotive—save in case of very infrequent service on very long lines.

3. On lines for heavy traffic steam would be more economical than electricity if motor and gearing have a combined efficiency as low as 60%, up to 100 miles per hour.

4. At speeds of 100 miles per hour and upward, neither steam at 90% nor electric apparatus at 60% efficiency is commercially practicable.

5. Inasmuch as the saving of coal in stationary, as compared with locomotive engines, is one of the chief causes of the greater economy of electric propulsion, at any speed, this advantage will increase with that difference and also with the price of coal.

6. Any cause other than inefficiency of motor which increases the power required to haul a ton of freight, increases the advantage of electricity, since it enlarges the value of the coal difference and the dead-weight difference.

Thus bad roadways and large areas exposed to atmospheric resistance, as in street railway work, lower the speed at which electric motors of any efficiency become cheaper than steam.

7. In descending to small locomotive units, the electric motor loses less, relatively, of its advantage—another reason for success on street lines.

8. Multiplying the number of motors should be as far as possible avoided.

9. In special cases cleanliness and compactness of electric machinery may be of great value; in case of very frequent stops the possibility of returning to the line the energy now wasted in brakes may be of considerable value. This, however, can be obtained only by sacrifice in

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* As an interesting example of an unusual load in steam service, I may refer to one consisting of 156 loaded cars and two cabooses, hauled over the Mi-ssissippi Valley Railway, December, 1885. The load consisted of:

	Pounds.
Cotton weighing	3,226,000
Cars weighing	3,239,000
Engine and tender weighing	147,000
	6,612,000

Speed was about ten miles per hour.

the matter of dead-weight, as normal working is implied to be at comparatively low magnetization. Loss due to low efficiency in starting can scarcely be avoided either in steam or electric engines.

10. Other minor pros and cons might be enumerated, but I believe that in considering the general economic results of the two systems we reach more definite conclusions.

While only one condition of station working has been taken for final comparison, that case is an average one, and comparative results would be but slightly affected by ordinary variations. Extreme cases may be readily determined from the tables and formulas presented.

11. Some differences of opinion as to the proper values for the various constants are to be expected, but I believe these differences, taken all along the line, would nearly balance between positives and negatives, leaving the general results and the method unchanged.

Growth of Traffic on the Great Lakes.

The accompanying table, showing the principal propeller lines now plying on the great lakes, we compile from an article in the Detroit *Free Press*:

Line or boat.	Owner.	Tonnage.	Value.
Northern S. S. Co.. Six steel steamers built 1888-89 by Globe Shipbuilding Co., of Cleveland.	Great North. Ry. Co.	11,310	$1,345,000
Mutual Trans. Co.. Three steel steamers built 1888-89 by Globe Shipbuilding Co.	Cleveland syndicate.	4,992	$560,000
Minnesota S. S. Co. Six steel steamers, built 1888-89 by Globe Shipbuilding Co.	Minnesota Iron Co.	11,016	$1,200,000
L. Superior Iron Co. Two steel steamers built 1890 by Cleveland Shipbuilding Co.	L. Superior Iron Co.	3,400	$330,000
Cleveland I. M. Co. Two Steel steamers built 1889 by Cleveland Shipbuilding Co.	C. Iron Mining Co.	3,465	$400,000
Wolf & Davidson S. S. Co. Four wooden steamers built 1887-90 by owners at Milwaukee.	W. H. Wolf & others.	4,000	$600,000
Five steel cigar-shaped barges. Built at Duluth 1888-90. (One cigar-shaped steamer now building).	Capt. A. McDougall.	5,140	$385,000
West. Trans. Line. Four steel, 2 iron, 10 wooden steamers.	N. Y. C & H. R. R. R.	22,952	$1,554,000
Lehigh Valley. Five wooden and 6 steel steamers, the latter built 188 -90 by Globe Shipbuilding Co., Cleveland.	Lehigh Val. R. R. Co.	12,000	$1,767,000
Anchor Line. One steel, 7 iron, 9 wooden steamers.	Pennsylvania R. R. Co.	10,000	$1,495,000
Union Steamb't Co. Five wooden, 1 iron, 3 steel steamers. Two of the last built 1887-88 by Union Dry Dock Co., Buffalo.	Union Steamb't Co.	7,090	$1,378,000
Eleven wooden steamers. (Own also 11 schooners.)	M. A. Bradley, Grover and others, Cleveland.	7,500	$800,000
Lackawanna Line. One wooden, 1 iron, 2 steel steamers, the last built 1888 by Cleveland Shipbuilding Co.	D., L. & W. R. R.	6,000	$490,000
Two wooden steamers. Built 1890 by Davidson, West Bay City, Mich.	Fairport For. Co.	2,300	$300,000
		111,475	$12,599,000

Many of the above figures are only approximations as to the tonnage and value, but the total gives some idea of the marvelous development which the last three years have witnessed in the lake transportation traffic, since it will be noted that a great proportion of the above vessels have been completed since 1887. While this includes the bulk of the iron and steel steamers built in that time, however, it is but a partial showing of the real growth of traffic. Besides the above the *Free Press* publishes a list of 98 vessels, all built since 1886, whose total value is $11,865,000. It thus appears that including equipment a sum considerably in excess of $25,000,000 has been invested in the lake traffic during the past three years.

To realize what an addition this means to the traffic capacity of the country it is to be remembered that a dollar invested in this manner is two or three times as effective in carrying traffic as when invested in a railway plant.

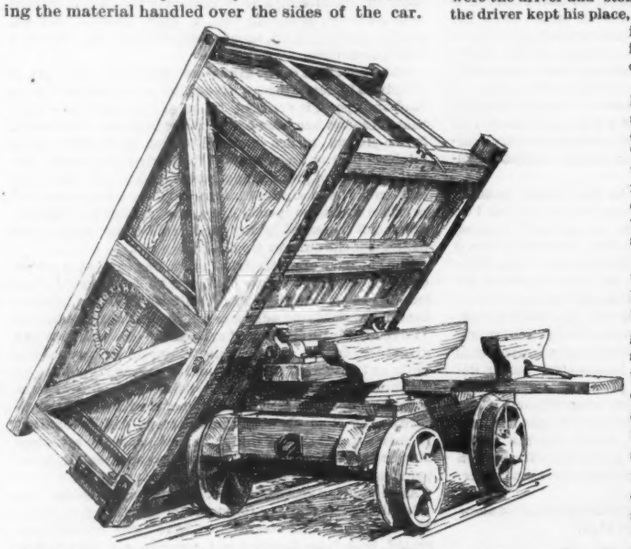
This sudden and enormous growth in traffic indicates that the possible profits in lake transportation have just been discovered. The boom in shipbuilding still continues, and with the completion of the new canal at the Sault Ste. Marie, which will make possible the use of larger vessels of greater draught it is likely to keep up for some time to come.

The fastest boats on the lakes are the *Owego* and *Chemung*, owned by the Union Steamboat Co. of Buffalo. They are 350 ft. long over all, driven by the largest triple expansion engines in use on the lakes, and make over 16 miles per hour. The *Owego* has just broken the record from Buffalo to Chicago, making the run in a little over 54 hours. These boats are not as economical freight carriers, however, as other boats on the lakes. The largest load ever carried on the lakes was 3,249 net tons of ore, taken by the steel propeller, *Pontiac*, owned by the Cleveland Iron Mining Co., from Escanaba, Mich., to Cleveland.

A Rotating Dump Car.

The novel design of dump car shown in the accompanying illustration has been recently put on the market by the Bloomsburg Manufacturing Co., of Bloomsburg, Pa. The engraving, which is made from a photograph, shows clearly the especial features of the car.

As will be seen it is either end dump or side dump as desired, and the trunnions on which it tips are set so near to the side of the car that the necessary angle of elevation for emptying its load is secured without elevating the car body to an undue extent. This is an important matter when cars are filled with hand shovels. The lower the car body is set, the less effort is expended by the workmen in raising the material handled over the sides of the car.



ROTATING DUMP CAR, BUILT BY THE BLOOMSBURG CAR CO., BLOOMSBURG, PA.

Instead of revolving on a central pin or plate this car turns on two circles of V-shaped cross-section which hold the oil much better than flat plates.

In general construction, as may be seen, the cars are solidly built for hard service. They are fitted with patent closed hub wheels to keep the axles free from dirt and grit, and may be run for three months or so with a single oiling.

A Norwegian Boiler Explosion.

In our issue of June 7 we illustrated and described a remarkable Norwegian boiler explosion, in which the rear one of two engines hauling a freight train loaded itself upon the back of the engine in front, somersault fashion, owing to an explosion rupturing the lower part of the barrel of the boiler. A letter from Mr. CARL PIHL, giving full details of the occurrence had, as we then said, miscarried, and we are only now in receipt of a copy of it, the essential parts of which are as follows:

On Dec. 22, 1888, a freight train hauled by two coupled engines was leaving the water crane when an explosion of the boiler of the second engine occurred, and caused the whole engine, by the recoil from the pressure against the frozen ground, to be thrown vertically in a somersault fashion from the rails onto the front engine, where it rested in the way shown in the photographs. In this position, untouched, it was brought to the shops, about 12 miles off, on the back of the leading engine.

As to the cause of the accident, there was much doubt, as the engine in May previous had undergone a thorough repair, and the boiler had been examined and tested with 200 lbs. per sq. in., the working pressure being set at 120 lbs. only. There were, however, certain indications pointing in the direction of the supposition that the boiler from some cause or other at the time had been short of water, although the evidence from the driver and stoker, as well as from the superintendent, was against such negligence. Nevertheless, this explanation seems now to be the only feasible and admitted one, and is supported by the following circumstances and facts: Just as the engine was put in motion the driver as well as the stoker heard a hissing noise, as if coming from below, so apparent that the driver stepped back, thinking something amiss with the gauge glass. Immediately after the explosion took place. Next it was proved by the examination of the water gauge that the opening of the lower inlet to the boiler had been much contracted by incrustation, and thereby temporarily stopped by floating particles or grit, preventing the water from falling in the glass, and thus deceiving the men as to the true water level inside the boiler.

The part giving way was quite close to, and parallel with, the seam running from the fire-box forward to the next ring of the boiler. The size of the ruptured piece was about 5 ft. long by 3 ft. 6 ins. wide. The torn plates looked pretty sound, though some grooving of about 1-16 in. was apparent, no doubt causing the weakening of this part of the boiler.

At the time of the explosion the driver, stoker and guard were standing on the engine; the driver was thrown into the next field with a broken leg, the stoker was thrown to the other side, a little bruised and scalded, and the guard was but very little hurt. On the front engine were the driver and stoker; the last one jumped off, but the driver kept his place, shutting off the steam and bowing himself down under the coming engine overhead, and thus escaped any injury.

The engine in question was delivered in 1861 by Robt. Stephenson & Co., and had run about 480,000 miles before the accident. The sister engine, delivered at the same time, had run 540,000 miles, and its boiler was condemned, though standing a pressure of 300 lbs. per sq. in. without sign of weakness.

The area of ruptured plate was thus about 17.5 sq. ft., being much larger than could be inferred from the photographs taken. At 120 lbs. per sq. ft., this meant 2,100 lbs. of unbalanced upward pressure considered statically only, but as a jet of solid water escaped through this hole, and as the sudden reduction of pressure would permit a large amount of water to flash instantly into steam which would act upward dynamically, the strange effect produced is readily explained, after the event; although it was still a very curious fact that the explosion should have confined itself to the one plate which first ruptured, and so permitted the escaping jet of water and steam to have a rocket-like effect upon the engine as a whole only, instead of tearing the boiler into pieces; and, moreover, it was difficult to imagine from the photograph that the ruptured plate could have been even so large as it was. Prof. R. H. THURSTON sends us an interesting paper of his on boiler explosions (Trans. Am. Soc. M. E., Vol. VI.), showing that there is energy enough bottled up in the boiler to throw it some miles high in the air if it could only be all effectively applied, which is undoubted; but ordinarily it cannot be so applied as to turn the boiler as a whole, with all its attached parts, into a projectile. When rupture begins, it generally ends in destruction.

The Efficiency Record of the Westinghouse Test Freight Train.

Most of our readers will remember the remarkable test trip around the country made in 1887 by a train of fifty empty freight cars which had been fitted up by the Westinghouse Air Brake Co. to show practically what their improved quick-action brake was capable of, soon after they had finally succeeded in perfecting this brake so as to completely avoid the terrible shocks which, in both the first and second series of Burlington brake tests, had seemed to disprove the possibility of using air alone on very long trains unaided by some process of electrical application.

Strange to say, remarkable as these tests were, no tabulated computation of the actual efficiency of the brakes in the several tests has ever yet been made, or at least published. The nearest approach was

made by some partial computations which we made and published at the time; but as these records are likely to long continue the most complete and satisfactory evidence which exists of the practical capabilities of air brakes, it has occurred to us that it would be well to make a complete tabulation of all the results of the tests, as a matter of permanent record, which we do in the accompanying table:

As will be seen from the table, the tour of the test train about the country occupied just two months in all, during which period test runs were made at 12 different cities, or every five days on an average, including Sundays.

The tests were in each case attended by many hundreds of railway managers, engineers, press representatives, prominent citizens, and professors and students of technical schools. The results, as given in the table, have been widely published, and are undisputed. The computations made from the records are made by the simple process described below. The train consisted of the 50 freight cars which were used at the competitive tests at Burlington, Ia., in April, 1887; each car 38 ft. 4 ins. long, and of 60,000 lbs. capacity; total length of train, 1,900 ft.; total weight, 2,000,000 lbs.. as nearly as may be.

The brake was the standard apparatus, adapted for ordinary service, and such as the company has now for nearly three years applied to all cars, both freight and passenger. Therefore it should and does do as well in regular service as it did in these tests.

Two engines were used in the first test at St. Paul; one engine only in all the other tests. Fractions of miles and of feet are omitted from the records of speed and of distance run.

At each place visited 10 different runs or tests were made, and always in the same order (unless lack of time or other chance cause compelled abridgment or change of the programme.)

These tests may be broadly divided into the two following classes:

1. *Those made with an easy brake leverage to give light pressures*, or about 0.6 of the weight on wheels of the empty cars, as explained in detail in our description published in 1887. This is considered about the best working pressure for freight service if all danger of sliding the wheels of empty cars is to be avoided. The first 7 of the 10 runs were made with this brake leverage, of which the 1st, 2d, 4th, 6th and 7th are tabulated below, with averages and computations of efficiency, which we have added.

2. *Those made with a greater brake-leverage to give higher pressures*, or about 0.85 of the weight on wheels of the empty cars. This change of pressure was effected in a few moments by the mere changing of a fulcrum pin, and left the workings of the apparatus otherwise unaffected. It increased the efficiency of the brakes by almost exactly 50%, or the amount of the difference in pressure, as will be seen in the table and below. The danger of so high a pressure is that it will slide the wheels at slow speeds under empty cars; but where cars rarely are entirely empty, and the utmost efficiency in cases of emergency is of high importance for outweighing any slight injury to the wheels, as in most kinds of rapid transit, suburban and limited service, it is an entirely admissible and proper pressure; it being remembered that the engineman is under no necessity to use this high pressure unless he chooses, and never does to do so except in some real or fancied emergency. Our own feeling is that passenger trains of all classes should be fitted with these high pressures, pains being taken to instruct all enginemen as to the certainty of their sliding some of the wheels if they use it, and they being held correspondingly responsible.

The several stops were in detail as follows, *with the low brake pressures*:

1. Emergency stop, train running 20 miles an hour (tabulated).

2. Emergency stop, train running 40 miles an hour (tabulated).

3. Applying brakes while train is standing still, to show quickness of application. In all cases the brakes went fully on, at the end of the 50-car train, in less than two seconds, or with about the velocity of sound.

4. Emergency stop, with passengers aboard; speed, 40 miles per hour (tabulated). The effect of the added load of passengers in slightly reducing the efficiency of the stop is visible on comparing 2 and 4.

5. Service stop, and time of release. Showing the kind of stop made when a sudden stop is not necessary, and how promptly the brakes can be released. The record of the stops is not reproduced.

Table Showing the Combined Retarding Efficiencies of the Brakes and Rolling Friction in Per cent. of Weight on the Braked Wheels, in the Several Series of Tests of the Westinghouse Test Train, made at Various Cities in October-December, 1887.
Train consisted of one engine and 50 empty freight cars, weighing 1,000 net tons in all. The entire weight of the train was unbraked. Actually, the engine, truck axles a part of the tender weight, about 20 tons in all, or 0.2 per cent. of the weight of the train, was unbraked.

Place and Date of Test. 1887.	Down grades.	Brake leverage set to give pressure = 0.6 × weight on wheels of empty cars.																						Brake leverage increased to = 0.9 × wt. on wheels, empty cars.																			
		1. 20 m. p. h., 50 cars.						2. 40 m. p. h., 50 cars.						4. 40 m. p. h., 50 cars.				6. Hand brakes, 20 m. p. h.				Breaks away 50 cars.		8. 20 m. p. h. 85 cars.						9. 40 m. p. h. 50 cars.						10. { 20 freight cars. 12 pass. cars.					
		Miles, speed.	Feet, distance.	Seconds, time.	Total vert. ft. energy y dest'd	P. c. efficiency.		Miles, speed.	Feet, distance.	Seconds, time.	Total vert. ft. energy y dest'd	P. c. efficiency.		Miles, speed.	Feet, distance.	Seconds, time.	Total vert. ft. energy y dest'd	P. c. efficiency.		Miles, speed.	Feet, distance apart.	Miles, speed.	Feet, distance.	Seconds, time.	Total vert. ft. energy y dest'd	P. c. efficiency.		Miles, speed.	Feet, distance.	Seconds, time.	Total vert. ft. energy y dest'd	P. c. efficiency.		Miles, speed.	Feet, distance.	Seconds, time.			
St. Paul, Oct. 15.	Feet per mile. 13.6	30	200	15	14.72	7.7		30	490	15	47.29	9.6		30	583	15	50.12	8.6		20	100	25	59	30	100	0	14.48	13.3		37	327									
" 21.	Per cent. .36	19	172	11	13.27	7.4		37	480	15	48.60	10.1		37	470	15	41.04	8.7		20	130	25	62	30	109	6	14.20	11.8		33	272	11	38.66	14.2						
Chicago, " 25.	Level	21	184	10	14.30	8.8		30	507	18	51.08	10.1		34	502	17	45.58	9.7		20	130	25	62	30	109	6	15.29	14.0		38	377	11	55.03	14.6						
St. Louis, " 28.	82.0 1.0	20	170	11	17.19	9.3		35	542	17	45.64	9.0		35	573	17	54.09	9.4		20	130	25	62	30	102	6	15.17	14.9		41	425	12	63.72	15.0						
Cincinnati, Nov. 1.	50.0 .90	20	264	12	15.90	8.6		43	718	20	71.00	9.0		40	686	19	57.66	8.8		20	130	25	61	30	96	6	14.98	15.5		40	375	11	59.65	15.9						
Cleveland, " 4.	60.0 .76	20	265	12	21.50	9.8		40	719	20	71.00	9.0		39	646	19	57.95	8.9		20	130	25	60	30	93	5	14.77	15.9		40	414	13	59.33	14.3						
Buffalo, " 6.	66.0 .61	20	214	10	16.98	7.9		40	679	18	59.94	8.9		37	590	19	52.43	9.0		20	130	25	60	30	78	5	13.34	17.1		40	358	12	59.16	16.5						
Albany, " 9.	35.0 .66	20	158	10	15.34	9.6		30	500	18	49.71	8.9		34	483	17	44.71	9.3		21	1,035	22	62	30	111	8	15.01	13.6		38	{ 319 347	{ 12 13	53.69	{ 16.8 15.8						
Boston, " 14.	40.0 .76	19	123	10	13.75	11.2		32	406	16	39.43	9.7		41	672	20	66.42	9.8		21	2,137	22	91	30	91	6	18.10	19.9		45	{ 495 1,204	{ 27 19	76.84	{ 6.4 4.0						
New York, " 21.	83.0 1.0	23	203	12	20.82	10.3		41	674	20	66.42	9.8		36	579	18	50.87	8.6		18	1,889	75	57	30	67	6	14.93	17.1		49	{ 647 952	{ 19 23	90.66	{ 9.7						
Phila., " 28.	44.0 .84	23	264	14	21.01	9.0		36	603	19	50.99	8.6		38	679	18	50.87	8.6		20	1,643	75	67	30	63	6	16.48	20.3		40	359	11	60.39	16.8						
Washi'g'tn, Dec. 6	53.0 1.0	19	159	10	14.41	9.1		42	694	21	69.56	10.0		42	718	21	69.80	9.7		20	1,643	72	67	30	63	6	15.75	16.6														
" 14.	47.0 .89	20	184	11	15.84	8.6		40	649	21	62.57	9.6		40	673	20	62.80	9.3		20	1,720	72	29.52	30	85	6	15.75	16.6		45	{ 494 890	{ 14	76.30	{ 15.5 8.6						
Pittsburg																																										
Av. of all tests....		21.2	199	11	17.45	8.97		37.8	583	18.2	55.53	9.53		37.5	593	18.2	54.57	9.16		20.4	1,720	71.9	57.88	29.52	67	6	15.21	15.83		38.6	363	11.6	55.07	15.30			488	11.5	73.79		
																																							488	11.5	73.79		
																																							808	22.3		15.40	
																																										8.76

*Passenger train only. Compare with freight train in Test No. 3.

The brakes released in all cases in four seconds, and at Boston in three seconds.

6. Hand brake stop, made at 20 miles an hour, with five brakemen at their posts. (at Buffalo there were seven brakemen). The comparative efficiency of the hand brakes would appear much better on a level than it does on these down grades, and still better on an up grade, for reasons that need hardly be explained. On the other hand, in regular practice hand stops as good as these could hardly be made since all the brakemen were standing alertly at their posts.

7. Breaking train in two. The train was allowed to part near the middle, and the resulting separation is due to the fact that part of the engine weight is unbraked.

With the high brake-pressures: all emergency stops, and all tabulated:

8. Train running 20 miles an hour.

9. Train running 40 miles an hour: leverage as in No. 8.

10. A train of 20 freight cars and a train of 12 ordinary passenger coaches were run alongside of each other, on parallel tracks, and the brakes applied at the same time. This test showed the relative stopping power of the old and the new brakes.

The difference between the old and new brakes, we need hardly say, is chiefly that in the old brake there was no exit for the air in the train-pipe except the single one which had been opened on the engine, whereas in the new brake every brake which goes on opens a new exit for the confined air into the successive brake cylinders. No one foresaw, or could have foreseen, before 50 car tests had been made, that this apparently slight difference could make so vital a difference in the working of the apparatus.

Comparing the average efficiencies developed in the several tests, as shown at the foot of the table, we have the following:

Per Cent. of Efficiency.	20 miles per hour.	40 miles per hour.
Low brake pressures.. (= 0.6 W).....	8.97 (hand 1.75)	9.53
High brake pressures.. (= 0.85 W).....	15.83	9.16 (passengers on train) 15.30 (50 cars) 15.40 (20 cars)

These figures indicate (1) that the efficiency is slightly greater the shorter the train, and this in spite of the greater proportionate loss from part of the engine and tender weight being unbraked; (2) that the average efficiency is practically the same in stops from all speeds. This is natural, there being on the one hand an increase in coefficient of friction as speed decreases, which improves the average of slow speed stops; and on the other hand, a certain loss of time in getting the brakes fully on, which is constant at all speeds, and so of more proportionate disadvantage to slow-speed stops than high-speed. When brake pressures are high, the slow-speed stops gain more proportionately from the first cause than they lose from the second, and show somewhat the better average; when the brake pressures are low, the reverse is the case, and the slow-speed stops show a somewhat inferior efficiency; but the difference in either case is small.

The efficiency percentage includes the combined efficiencies of the brakes and rolling friction, which act together to retard the train. The average rolling friction may be taken as approximately equal to 8 lbs. per ton for the 20-mile stops, and 12 lbs. per ton for the 40-mile stops, equivalent to 0.4 and 0.6% grades respectively, or to 0.4 and 0.6% cent. Substracting these from the percentages given gives the retarding efficiency of the brakes alone in per cent. of the total weight resting on the wheels. Practically all the weight of the train was braked except the engine truck. A slight correction should be made for this, tending to increase the brake efficiency shown, which is neglected.

The efficiency as given in the table is computed by the formula:

$$E = \frac{H + G}{d}$$

in which E = the per cent. of efficiency, H = the "vertical head" in feet represented by the velocity (including an allowance of 6 + per cent. for the rotative energy of the wheels), or the height to which the stored energy in the train alone would lift the train before it came to a rest, d = the distance run in feet after brakes were applied, and G = the fall in feet of the track in the distance run. A table of values of H is given on page 536 of "The Economic Theory of the Location of Railways."

A Temporary Bridge Support.*

The foundations for the piers of the channel span, and for the two piers east of the channel span, of the Ohio River bridge at Steubenville, O., were laid in 1862 and 1863, and the masonry of these piers was completed in 1864. The bridge consists of eight spans, and its total length is 1,190 ft.

At the time of its completion, in 1865, it was the only iron railway bridge across any of the navigable tributaries of the Mississippi River, and it was the longest span iron-truss bridge ever attempted up to that time.

The foundations for the piers of this bridge consisted of ordinary timber platforms, composed of three or four courses, bolted together and sunk into pits excavated in the river bed by dredging machines. The sequel will show that this method is not to be recommended as an example for general observance. After the foundation pits had been excavated to their proper depths, the timber platforms were floated into position, secured by guide piles at the corners, and gradually lowered by the increasing weight of the masonry as it was laid on the platform, until they finally settled upon the bottom of the pits. It was very difficult to maintain a smooth and level surface at the bottom of these pits during the lowering of the platforms, the under-current washing out the shifting material in some places and depositing it in others, causing great inequality at the bottom, and preventing platforms from finding uniform bearings. This was especially the case with Pier No. 5, which is the pier between the two spans next east of the channel span.

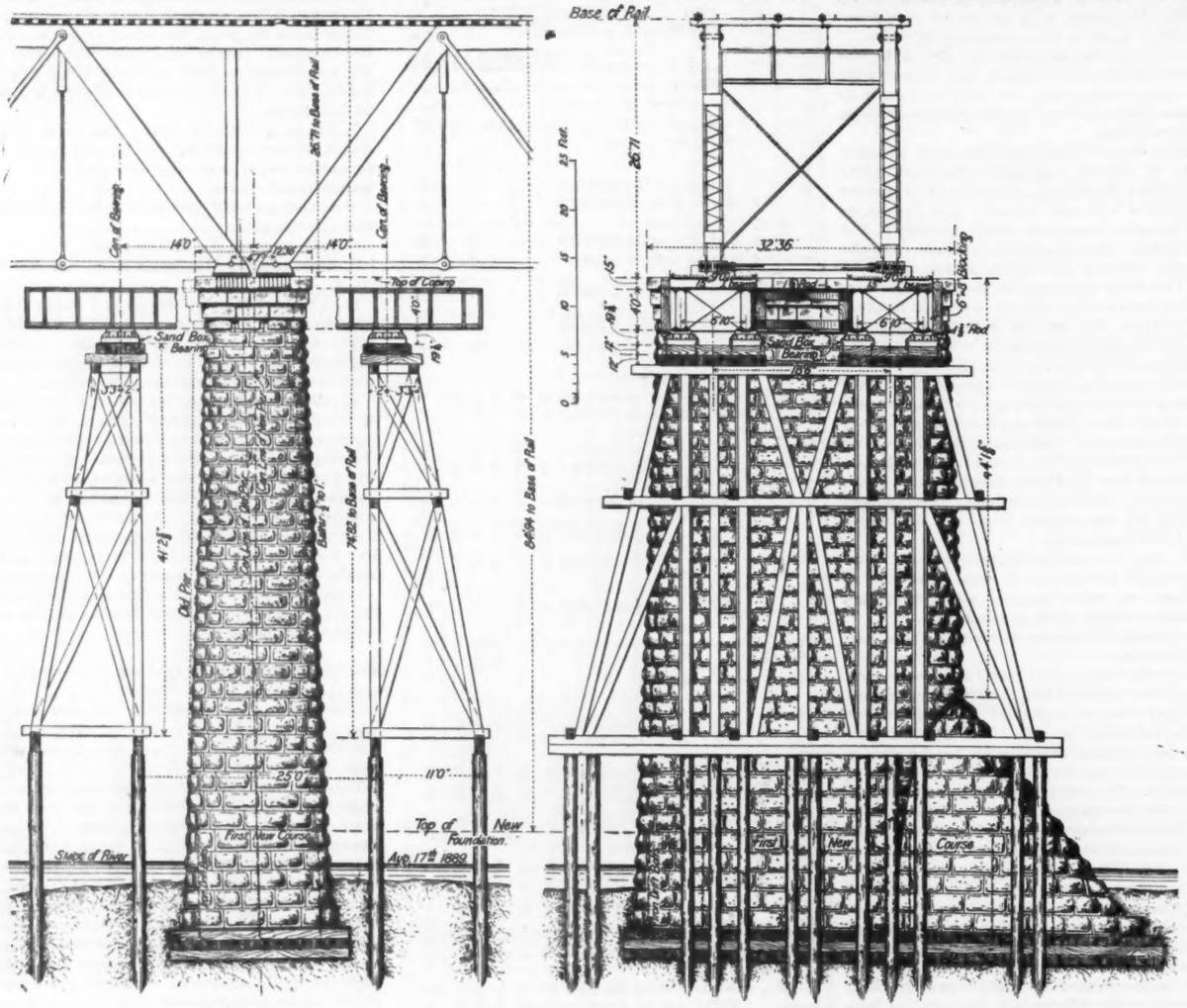
When the foundation pit for this pier had been dredged out to its required depth, the platform, consisting of three courses of 12-in. pine timber and a top layer of 2½-in. plank, was floated into position, and gradually sunk by the increasing weight of the masonry built upon it. It was not expected that the platform would at once come to a full bearing, and its slightly irregular settling during the laying of the first two or three courses of masonry created no surprise; but after the fifth course had been laid it was supposed that a firm bearing had been reached, and that no further settlement would take place. Levels were taken on top of this course, showing a depression of 7 ins. at the up-stream end of the pier as compared with the down-stream end; and an average transverse depression along the east side of the pier of 1½ ins.

The top of this course was then trimmed to a uniformly horizontal surface, and the masonry continued to the top finish, without signs of unequal settling. But just before the erection of the superstructure it was discovered that the pier had suddenly settled westwardly, so as to show on its top a departure of about 22 ins. from its normal longitudinal axis. This movement eliminated the batir on the west side of the pier entirely, and increased it on the east side from the original ratio of ⅛ in. per foot to about 1 in. per foot. The question then arose whether it would be safe to place the iron superstructure upon this leaning pier. A careful examination found the masonry in perfect condition without a sign of fracture in the stone, or of a rupture in the joints. It was evident that the west edge of the platform had at first lodged upon the slope of the pit and rested there until the pier was completed, when it started and settled to the bottom of the pit, carrying with it in its movement the body of the pier intact. There was still room enough on top of the pier for the support of the trusses, although the bed plates of the end posts of the eastern span came rather uncomfortably close to the edge of the coping.

After a short consultation it was decided to erect the superstructure upon the pier as it stood, protect its base with a large deposit of riprap, make regular periodical observations, so as to detect any possible additional movement, and trust to luck for the rest.

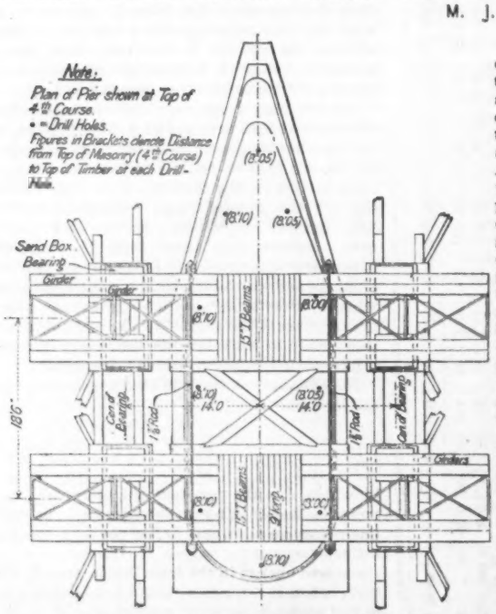
The pier has stood firm and carried its load from that time until last fall, a period of 25 years.

During the summer of 1888 the four eastern spans were



End View. Side View.

A TEMPORARY BRIDGE SUPPORT: METHOD USED IN RENEWING A PIER OF THE STEUBENVILLE BRIDGE, P. C. & ST. L. R. R. M. J. BECKER, CHIEF ENGINEER.


Note:
Plan of Pier shown at Top of 4th Course.
• = Drill Holes.
Figures in Brackets denote Distance from Top of Masonry (4th Course) to Top of Timber at each Drill-Hole.
Sand Box Bearing
Girder
Cen. of Bearings
Cen. of Bearing
Clinkers
18'6"

PLAN OF TEMPORARY BRIDGE SUPPORT; STEUBENVILLE BRIDGE.

*A paper by MAX J. BECKER, Past President Am. Soc. C. E., read before the Engineers' Society of Western Pennsylvania.

taken down and replaced with a double track superstructure. It had been decided to take down and rebuild the leaning pier at the same time, and it was the intention to accomplish this by placing the two spans adjacent to this pier upon falseworks, simultaneously, and begin the removal of the pier just as soon as the track had been placed upon the falsework trestles and the dismantling of the trusses had commenced. By working them vigorously day and night on the removal and rebuilding of the pier, we hoped to complete it in time for the reception of the new superstructure. Under favorable circumstances this could have been done, but, unfortunately, during the entire working season of that year the Ohio River continued at such a high stage as to make it very hazardous, if not impossible, to undertake the task. Meantime all preparations had been made for the erection of the superstructure of the two spans; the falseworks had been placed in position, and it was decided not to delay or incur any risks upon this part of the work by waiting for a possible favorable opportunity to renew the pier. It became, therefore, necessary to provide for the removal and rebuilding of the pier by a different method.

After a careful consideration of all conditions, it was decided to erect the two spans and rest their adjoining ends upon the old pier, and, after removal of the falseworks, build a strong temporary wooden trestle pier on the outside of and inclosing the leaning masonry pier; lift the ends of both spans of the superstructure clear of the masonry; remove the coping and some parts of the upper courses, place heavy plate girder beams on the temporary wooden trestle pier, introduce strong girdiron pedestals to carry the end posts of the trusses, and after placing cast-iron sand boxes under the plate girders, where they rested upon the temporary trestle pier, lower the two bridge spans, and carry them upon these supports until a favorable condition of the river would permit us to remove and rebuild the defective pier.

This arrangement is fully shown on the accompanying engravings.

Two rows of piles were driven on each side of the pier, in the positions shown on the plan; there were 12 piles in each row, or 48 piles in all; they were fitted with strong wrought-iron points, so as to penetrate the riprap which had been placed around the pier from time to time, and which had become very solid and compact. The piles were cut off at an elevation of 17 ft. above low-water mark, double capped longitudinally, cross braced between the two adjacent rows, cross-capped by notched timber ties to resist the thrust from the leaning trestle posts, and two stories of ordinary trestles erected, the inner posts being perpendicular and the outer posts inclined; each story capped longitudinally and transversely, cross-braced and bolted. On top of the upper longitudinal caps two solid timber platforms were laid, one on top of the other; on top of the upper platform were placed the sand boxes, which were filled with dry sand after the outflow holes had been closed with wooden plugs; the iron cover lids were placed on the tops of the sand boxes, and the four pair of plate girders were then swung into position. These plate girders were built of sufficient strength to hold up the two adjacent ends of the two spans of the bridge and the live load passing over them amounting in the aggregate to about 800 tons. During this operation, however, only one track was used over the bridge, although it was built and is now used as a double-track structure. The plate girders were made 50 ft. long, which was longer than necessary for the purpose, but their flanges and webs had to be of such extra dimensions for this work as to correspond to the sizes of a 50-ft. span under ordinary traffic, and they could, therefore, be used to good advantage elsewhere, after having served their purpose at the Steubenville bridge.

Meantime the two spans of the bridge had been resting upon the old pier, the coping of which had been partly removed at the time of the erection of the trusses to make room for the four sets of gridiron pedestals, each composed of eight heavy 15-in. I-beams, connected together by top and bottom plates which have been placed under the end posts of the trusses to serve as copings; these gridiron pedestals were 9 ft. long, reaching entirely across the two pairs of plate girders, and the trusses of the bridge rested upon them centrally.

The superstructure of the two spans, whose ends rested upon the gridiron pedestals placed on top of this pier, had been completed in November, 1888; the falsework which had served in their erection were removed in December, 1888; the pile driving for the temporary supports was commenced Feb. 16, 1889, and on April 1, 1889, the trestles had been erected.

Before the plate girders could be swung into position the masonry had to be removed as far down as the bottom of the girders; blocks of masonry, however, had to be left standing between the lines of girders to carry the bridge until the plate girders were placed in position. The cutting away of these blocks of masonry was a tedious and somewhat dangerous operation, and we felt quite relieved when the girders had been placed and wedged up under the gridirons so as to carry part of the load and relieve the remaining blocks of masonry of part of the pressure. This was safely accomplished on June 4, 1889.

All was now ready to dismantle the pier, but the stage of the river continued too high to admit of the adjustment of the tilted foundation platform, which we hoped to accomplish before starting the new masonry for the pier, and the work remained in this condition until Aug. 6, 1889, when the tearing down began, and on Aug. 14 the pier had been removed to the top of the fourth course from the bottom.

An examination of the foundation platform was then made by drilling through the remaining courses at ten points around the circumference of the pier to the top of the timber, when it was found that the western edge of the platform was five inches lower than the eastern edge. The lower four courses of masonry appeared in perfect condition, although, of course, inclined at the same angle as the platform.

The riprap around the pier was found to be very compact, and everything seemed to indicate that it would be safer to let the old platform and four lower courses of masonry remain, and build upon this thoroughly settled foundation, than to tear it all up and start a new one of similar kind, with a possibility of its settlement and a repetition of the former trouble.

Pile-driving for a new foundation was too risky on account of the liability of disturbing the trestle supports which now carried the bridge and traffic.

The new work was therefore started with the fifth course of masonry, the top of which was trimmed to a level surface on Sept. 5, 1889. On Oct. 10 the load was transferred from the girders to the completed masonry, and on Nov. 20 the last piece of coping was laid after the girders had been removed.

There are 860 cu. yds. of masonry in the new pier above the fourth course.

The gridiron pedestals remain in the work; but they are concealed by the surrounding coping stone, and the spaces between the I-beams are filled up solid with concrete or Portland cement. The new masonry stands up well, and does not show the slightest indication of settlement.

Exclusive of the plate girders, which are now in use elsewhere, this work cost $12,059.84. A good pile foundation under the original pier would have cost about $1,500 more than the timber platform; but it would have saved the cost of the rebuilding, and spared us much trouble, anxiety and mortification.

DISCUSSION.

THOMAS P. ROBERTS: I will ask Mr. BECKER if any borings were made to determine the depth to solid rock beneath the pier? From my experience in dredging and sounding on the river, I would expect to find in the channel, or mid-river point, in the neighborhood of Steubenville, a coarse gravel and boulder bottom, which is generally compact and not to be disturbed, excepting by powerful currents.

M. J. BECKER: There were no borings made, to my knowledge, at the time the bridge was built there in 1855, nor in 1862 when the work was resumed. The indications were that no rock would be found at reasonable depth. In those days the foundations by means of caissons and pneumatic processes, although perhaps known, were considered entirely too difficult to be warranted under the conditions and circumstances. The material at the bed of the river was composed of coarse gravel mixed with boulders, and quite uniform. It was considered a good foundation and no doubt would have been a good foundation if it had not been for the unfortunate lodgment of the corner or side of one of the platforms, leaving an unsupported space underneath, which, when the entire load came on at once, yielded, causing the whole pier above to settle down and tilt over on its side.

I think if the platform had sunk squarely and horizontally on its bottom, there would not have been any difficulty whatever. The other piers are built on similar foundations, and there has not been the slightest movement in any of them. Some of them have been there for 35 years.

The work was hastened as much as possible. We pushed it day and night, and we laid the two courses of masonry, I think, on the ordinary piers in a day or a day and a night, and on the larger channel piers in about two days, the idea being to get down to the bottom as rapidly as possible, and avoid the accumulation of material flowing in.

THOMAS P. ROBERTS: In regard to the protection of ordinary bridge piers from erosion and undermining, it is my opinion that not enough attention has been paid to this detail by the engineers of our highway bridges constructed across the Allegheny and Monongahela rivers. These are navigable streams, and steamers "drawing all the water" must necessarily pass close to the riprapping. Under such circumstances there is a powerful "suck" or draught in the current which sometimes rolls away the stones, and is certainly capable of washing out all the finer or "bonding" particles of sand beween them. This process of washing out the sand intermixed with the riprap may, and does, sometimes extend to and beneath the foundations. Hence results the "squatting" or settlement of the whole mass in proportion to the percentage of solid matter lost. But as we must, from motives of economy, build bridges on this comparatively cheap plan of securing foundations, I have thought it would be the part of wisdom to surround the foot of the slope of the riprap with a line of sheet piling of heavy oak plank, driven as close as possible, and cut off at least two, or perhaps three, feet below low-water mark, so that boats will not damage them. In addition to this precaution if a foot or more of the bottom of the protection was well grouted, or, better, formed of concrete rammed down, and on top of this the largest kind of irregular-shaped stones, carefully laid, with interstices filled up with long stones, points up, there would be little trouble. The riprapping of the Ninth St. bridge had to be renewed every few years. It seems to me that the plan I have suggested involves little expense, but the custom has been to dump riprap stone around piers with a rather vague idea of its utility. It has been found by experience that it is best not to put a floor in these cribs, but to leave them open so that they can fill the pockets from above, and the cribs will remain perpendicular. The United States engineers now generally build their cribs and ice-breakers without any floors.

The Sault Ste. Marie Water Power.

Sault Ste. Marie will shortly develop her water power facilities under the direction of Mr. MALHOIT, the Power Co.'s engineer, and Mr. J. T. FANNING, consulting engineer. The St. Mary rapids will be utilized for this purpose. According to United States government engineers, the average flow through the channel is about 90,800 cu. ft. a second, while the head at the city amounts to 18.5 ft.

The project has been under discussion for some time. In 1888 a company was formed for the development of the power. Land was bought and bonds issued. Owing to financial difficulties the company sold all its rights to the city in January of this year.

The natural advantages are very great. Two parallel bays run out from the rapids, one at its head and one at its foot, with a difference in elevation of 18.5 ft. and a quarter of a mile apart. These bays will be connected by a canal, the soft shell limestone making the work very easy. Mr. FANNING estimates the cost of a 10,000 H. P. canal with all the buildings and machinery necessary at $125,000.

It is expected that the water power so gained will be largely used by wood paper manufacturers, as large quantities of timber of the best quality are found in the vicinity. This wood is now sent to many paper works in the United States and Canada, some of which will probably move to Sault Ste. Marie if the water power project is carried out.

Mr. FANNING, in his report, states that the average cost of maintaining 1 H. P. per year by steam is $80. At St. Paul, Minn., where the water power is rated at 18,000 H. P., $5 per year per H. P. was charged at first. This price has been increased within 7 years, until the last power sold was at the rate of $20 per H. P. Moreover, the supply is so uncertain in that city that 18 of the 23 flour mills in Minneapolis have been obliged to put in steam plants. The dam at this place, 1,850 ft. long and 40 ft. high, cost the government $200,000, and the water power companies have spent in addition large sums in building canals.

At Holyoke, Mass., there is a 15,000 H. P. water power. The dam here cost $575,000 to build and $263,000 have since been expended in maintaining it. Moreover, the power is only available during a part of the year and steam plants are necessary. Lowell and Lawrence, Mass., have about 10,000 H. P. available in each city which it has cost about as much as at Holyoke to develop.

The cost at Sault Ste. Marie of building the canals and machinery necessary to furnish the power at the different mills is estimated at $20 per H. P. per year, while the running expenses will be practically nominal. Moreover, the city can enlarge its plant so that 30,000 H. P. per year can be supplied when called for.

PERSONALS.

Mr. W. A. BACOT has been appointed engineer of highways of Richmond County, N. J.

Mr. A. C. HIPPEY has been appointed General Superintendent of the Norfolk & Western R. R.

Mr. C. G. WILSON has been appointed Superintendent of the Chicago, Burlington & Quincy lines in Iowa.

Mr. D. F. JACK has resigned his position as General Manager of the Jacksonville, Tampa & Key West Ry.

Prof. J. C. SMOCK has been appointed New Jersey State Geologist. He was for many years Dr. Cook's chief assistant.

Mr. E. L. HARPER, formerly Chief Engineer of the St. Louis & Peoria, has been appointed Assistant Engi-

neer of the Toledo, St. Louis & Kansas City, vice Mr. E. M. CULP, resigned.

Mr. H. R. WILLIAMS has been appointed Assistant Superintendent of the Northern Division of the Milwaukee & St. Paul Ry.

Mr. C. R. ARMSTRONG, a draughtsman of the Edgemoor Bridge Works, was drowned recently in the Delaware River near Edgemoor.

Mr. W. C. CUSHING will be appointed Engineer of maintenance of way on the first division of the Pennsylvania R. R., west of Pittsburg.

Mr. JOHN BRANDT, Superintendent of the Southern Pacific lines in Oregon, died June 28, in San Francisco, Cal. His successor is Mr. L. R. FIELDS.

Mr. JOHN PAGE, engineer of the Canadian government canals, died at Ottawa, July 2. He was remarkably successful as a canal engineer.

Mr. R. A. PARKE has been appointed Eastern representative of the Westinghouse Air Brake Co. His office will be at 160 Broadway, New York City.

Mr. F. T. HATCH, Engineer of maintenance of way of the first division of the Pennsylvania R. R., will be transferred to a similiar position on the Pittsburg, Cincinnati & St. Louis division.

Mr. J. A. SAGUE, Master Mechanic of the Rochester division of the New York, Lake Erie & Western R.R. has resigned to become Superintendent of motive power of the railways of the Island of Jamaica.

Mr. C. F. WOOD has been appointed Superintendent of the Knoxville (Tenn.) water-works, vice A. H. Martine, resigned. Mr. WOOD has been a member of the firm of WRIGHT & WOOD, civil and hydraulic engineers, for several years.

Mr. A. H. MARTINE has resigned his position of Superintendent of the Knoxville (Tenn.), water-works to become Superintendent of construction of the new water-works to be built at Middlesborough, Ky., by the Middlesborough Water Company.

Mr. G. W. KITTREDGE, the new Assistant Chief Engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry., will have charge of all that company's lines east of Indianapolis, and Mr. MORRIS, the old chief assistant, will have charge of all lines west of that city.

Mr. W. K. MCFARLIN has been appointed superintendent of maintenance and construction on the Chicago, Rock Island & Pacific Ry., with headquarters at Topeka, Kan. He will have charge of roadways, bridges, buildings, and construction on lines west of the Missouri River.

Mr. H. R. WILLIAMS has been appointed Assistant General Superintendent of the Northern District of the Chicago, Milwaukee & St. Paul Ry.; Superintendent J. B. CABLE has been transferred to the Kansas City from the Iowa & Minnesota division, where he will be succeeded by Mr. R. R. MINTURN.

NEW PUBLICATIONS.

BOOKS.

—*The Metallurgy of Steel.* By HENRY MARION HOWE, A. M., Harv. S. B. Vol. 1. New York: The Scientific Publishing Co. 4to, pp. 380; 228 tables; 228 cuts; well indexed. $10.00.

This magnificent and monumental work, which we judge to be beyond question the best which exists on its subject in any language, demands a fuller notice than we can give in this issue. We will only say now that it is a book which every user of steel in any form—in other words, every engineer—should have and read. The volume is highly creditable both to the author and the publishers, and no book has come to our table for a long time which we could so cordially recommend as completely covering its subject. Later we shall have more to say about the work.

—*Text-Book of Mechanics.*—With numerous examples. By THOMAS WALLACE WRIGHT, Professor in Union College. New York: D. Van Nostrand Co. 12mo, pp. 260, 205 cuts; $2.50.

We like this little book very much. It is not exactly our ideal for such a book, to make it equally useful both for the student and for reference; but the language is clear and concise, the illustrative examples numerous and exceptionally well chosen (a point of great importance in works of this character), and the style as clear and concise as it seems possible to make it. We can commend the work to students. The calculus is used somewhat freely; we are are disposed to think, too freely; but a large part of the work, and all the more essentail parts, can be followed without a knowledge of it. Authors of text-books do not sufficiently appreciate how great an aid it is to students, and how much it tends to increase the practical use of the calculus to give solutions where conveniently possible both by the calculus and the ordinary geometric analysis, that the two may be compared. Should this book ever be rewritten it might well be somewhat extended to accomplish this; but it is a very good little book as it is; and some of the examples are exceedingly novel and ingenious.

REPORTS.

—*Prospectus of the Cape Fear & Cincinnati Ry. Co.*—Cloth bound, 30 pp., with map and several very poor engravings, so poor that the maker did not venture to stamp his name upon them. Extracts from the volume will be found in Construction News.

—*Across Nicaragua with Transit and Machete.* By R. E. Peary, C. E., U. S. N. Pamph., 21.

A reprint of a lecture delivered before the National Geographic Society, May 3, 1889, and published in the National Geographic Magazine. Its character is sufficiently indicated by the title: a general description of Nicaragua along the line of the proposed canal.

—*Institution of Civil Engineers' Papers.*—Building in Earthquake Countries, by JOHN MILNE (a very complete and practical paper on its subject); Telephonic Switching, by C. H. WORDINGHAM; Taking the Temperature of the Cylinder Walls of a Steam Engine, by BRYAN DONKIN; Deep Water Quays in the Port of Cork, by PHILIP BARRY; Water-works in China and Japan (Shanghai, Hong Kong and Yokohama), by Messrs. J. W. HART, JAS. ORANGE and J. H. T. TURNER.

Interstate Commerce Commission Proceedings—Relative Rates.—In this case brought by the Manufacturers' and Jobbers' Union of Mankato, Minn., the Commission held that transportation charges are required to be relatively reasonable as well as reasonable in themselves, to prevent unjust discrimination between localities. A carrier may make low rates to certain localities because of competition or for other reasons, but is bound to make similar reductions to other points similary situated.

—*Second Annual Report of the Territorial Engineer to the Governor of Wyoming, for the Year* 1889. Pamphlet, 100 pp. ELWOOD MEAD, Cheyenne, Wyo., Engineer.

This report deals almost wholly with irrigation and allied subjects. The present irrigation status of Wyoming is given, together with much other matter of value to those interested in irrigation. An extended review of the report will be given in a subsequent issue of this journal.

—*Fifth Annual Report, Laconia and Lake Village Water-Works, for the Year Ending May* 31, 1890. Pamphlet, 12 pp. EDMUND LITTLE, Treasurer.

This is one of the very few annual reports of private water companies that come to us, the general policy of such companies seeming to be to keep from the public as many of the details of their financial operations, and sometimes even of the extent of their works, as is possible. This report shows in considerable detail all the operations of the company for the fiscal year, together with a summary of statistics conforming to the model of the New England Water-Works Association.

—*Annual Report of the Board of Public Works of the City of Milwaukee for the year* 1889. Pamphlet, 349 pp., several sheets of tables and two illustrations. G. H. BENZENBERG, City Engineer. During the year 21.89 miles of new streets and alleys were improved by grading, gravelling or paving at a total cost of $370,711, of which $174,785 was assessed against adjoining property. The sewerage system was increased in length by 14.91 miles, making a total length of 180 miles at the close of 1889. The total cost of the same has been $2,305,127. Plans and specifications were made in 1889 and the contract let to JNO KEARNEY, of Milwaukee, for a new stone dam across the Milwaukee river, 432 ft. long, and costing about $90,000.

Interesting features of the report are the total cost of constructing the water-works, as divided and charged to 13 different accounts; the total pumpage for the past 15 years, and the revenue per million galls. received therefor; and a brief description of the Milwaukee River sewer flushing works. The large screw pump at these works is illustrated in this report, and was described and illustrated in our issue of March 8, 1890, p. 218. The report also contains a plate illustration of the triple expansion, high service pumping engine built in 1887. Both engines were built by E. P. Allis & Co., of Milwaukee. The water-works engine showed in a 24 hours' test a capacity of 6,470,000 galls. with a duty of 118,186,312 ft. lbs. per 100 lbs. of coal, without deductions. The daily capacity of screw pumping engine is 500,000,000 galls. The official test of this engine showed a duty of 75,944,037 ft. lbs., and the average duty during the run of 1889 was 68,844,912 ft. lbs.

There should also be mentioned a diagram showing by weeks the average daily consumption of water in each month in 1888 and 1889 and the daily consumption by months in each year from 1875 to 1889, inclusive. The range in 1875 was from less than 1,500,000 galls. to nearly 4,000,000, and in 1889 from 17,000,000 to nearly 22,500,000 galls.

TRADE PUBLICATIONS.

—*The New Spur Gear Triplex Block*, and the Differential Pulley Block, Yale & Towne Mfg. Co. Pamph., pp, 16.

The new device to which this pamphlet is devoted seems to us one of real merit, and we shall shortly illustrate and describe it.

—*Globe Special Castings for Water-Works.* Illustrated pamphlet. Builder's Iron Foundry, Providence, R. I., 1890.

This pamphlet fully describes the Globe Spcial, and gives a list of about 150 water-works which have used the same in whole or in part, since July, 1886.

—*Catalogue of the Cincinnati Corrugating Co.*, Piqua O. Pamph., pp. 40.

No small amount of useful information in regard to the various uses of sheet and corrugated iron will be found in this pamphlet. The corrugated roofing made by this company has an extra deep corrugation at the lap edges, thus greatly facilitating the obtaining of a tight joint.

—*The National Water Supply Company.* Circular No. 3. Pamphlet, 24 pp. Cincinnati, O.

This pamphlet describes the Wagner Steamed Filter Well system which the company puts down, and gives some miscellaneous matter on water supply. Various wells of this class are described, those at the National Soldiers' Home, Dayton, O., being shown by an illustration. The number of water-works where these wells are in use is stated as 41, and of these 34 works adopted the wells after having first drawn upon some other ground water supply.

SOCIETY PROCEEDINGS.

American Society of Civil Engineers.—Annual Convention (*concluded*). The remainder of the evening of the first day (June 26) after the delivery of the President's annual address was occupied by what was really the special feature of the convention, the presentation by the stereopticon of some 300 (at a guess) photographic views of the Colorado Cañon, accompanied by a running description of the trip down the river and of the merits of the route for a railroad line, by Mr. ROBERT B. STANTON Chief Engineer of the Denver, Colorado Cañon & Pacific Railway, who has recently made with a party of 8 to 12 men the first and only trip ever made down the whole length of the cañon, or any considerable part thereof, since the trip of Major POWELL just after the war. We fully described and illustrated the first part of this trip Sept. 21, 1889, and in previous issues, and shall hereafter give a corresponding illustrated description of the entire route; therefore we will enter into no more details now, further than to say that the views and accompanying address excited such interest that it was not until 11:30 P. M. that the meeting adjourned, and that hardly any one strayed out before its conclusion, although many ladies were present.

A feature of special interest, lacking from our own presentation, was that a large number of the views were colored, without which it is impossible to appreciate the true grandeur and beauty of the scenery in this wonderful cañon, the coloring being almost as vivid as in the famous Yellowstone cañon. Reds, greens, yellows, blacks and blues (the last, of the water) are all found together, and all brilliant and decided colors, not mere tones, adding immeasurably to the interest of the scenery, which in itself is remarkable enough. Mr. STANTON'S opinion is that the route as a whole offers no more formidable difficulties than the average of the Colorado railways, although there is nearly 500 miles of continuous cañon scenery, the saving fact being that in the bottom of the valley there is a large amount of mere plow and scraper work, while almost everywhere in the cañon there is a bench of rock well above high water, giving a natural roadbed, even when the gorge as a whole is of the most rugged and forbidding character.

Mr. STANTON'S address was loudly applauded, as also great numbers of the views.

Friday morning, June 27, was occupied by an excursion to Johnstown, stopping at various points along the Conemaugh River, where the flood had done its most terrible work. The visit was signalized by the discovery the same morning of the bodies of three women who had been buried many feet deep under sand and gravel in the bed of the river, and which were yet, after the lapse of over a year, in a fair state of preservation. Of the work of the flood but little direct evidence now remains, except a general rawness and newness in the general aspect of the town, from which it must take many years to fully recover. The only point of technical interest which it was attempted to visit was the Cambria Iron Works, where most of the party spent all the time available. Messrs. ALEXANDER HAMILTON, Gen. Supt.; GEO. HAMILTON, Asst. Supt.; JOSEPH MORGAN, Jr., Chief Engineer, and C. S. PRICE, Metallurgical Supt., escorted the party about the works and afterward devoted a good part of the afternoon to the enlightenment of the Committee on Standard Rail Sections, which remained behind the main body.

The afternoon session opened with Prof. C. B. BRUSH'S paper on "One Way of Obtaining Brine," which we published in abstract last week. It was added in discussion that the salt somewhat injured pipes with ordinary lining.

Prof. H. T. EDDY then presented an elaborate paper on "A New Graphical Solution of the Problem, What Position a Train of Concentrated Loads Must Have to Cause the Greatest Stress in any Given Part of a Bridge Truss or Girder." The paper was a very elaborate and valuable one, although in a direction which has been pretty well worked over, and is quite unsuitable for abstract, being nearly 100 pages long. Those interested should obtain a copy for themselves.

Mr. WM. H. BURR then presented a paper on "The Three River Spans of the New Ohio River Bridge at Cincinnati," built by the Phœnix Bridge Co. He stated that it con-

tained the heaviest non-continuous trusses ever made, supporting double railway tracks, roadways and sidewalks. The weight of the three main spans was 5,000 net tons, total weight 10,180 tons, length 1 mile. The structure and the disasters which happened to its false works, etc., in erecting, were described in our issue of Jan. 12, 1889, and previous issues, and little beyond what we have already published, and much fuller drawings than we have published, appeared in the paper.

Mr. DESMOND FITZGERALD'S paper on "Comparison of Water-Supply Systems from a Financial Point of View," followed. It was confessedly an attempt to solve in a general way, an unsolvable problem, whether gravity, direct pumping or pumping to reservoir would be in the end most economical. This must depend largely if not wholly on special estimates for each particular locality, and as a rule but one system is reasonably possible at any one locality; but the author summarizes his conclusions when all three systems are possibilities as follows:

Whatever the size of the town, a gravity system would be most efficient whenever these conditions are all fulfilled; the supply of unquestioned present and future purity; the quantity sufficient for the needs of the next 20 years without great additional outlay; and the original cost such that 8 per cent. thereof will not be greater than 60 per cent. of the total operating expense, including interest and sinking fund.

A direct pumping system will be the most economical when the town is of such a size that its daily consumption will be more than one-half million gallons; when the supply is good and abundant, but situated at a low level: and when there are no great differences of elevation in the distribution system. If there are highly elevated portions, these, when of small comparative area, or consumption are best supplied with a reservoir system, having an independent force main. When the consumption is less than one-half million gallons, direct pumping with a reservoir stand-pipe of at least 20 hours' capacity, situated in the distribution system, will give the most economical results.

When a town is so unfortunate that its supply is insufficient during certain portions of the year, or when that supply is sufficient for ordinary needs, but affords no margin for fire protection, a reservoir of large capacity will then be necessary. Works of the latter kind can only be regarded as temporary in character, the inevitable growth of the city forcing soon radical changes and possibly reconstruction.

Although the writer is aware that no hard and fast rules can be formulated for a choice of a system, and that a hundred local circumstances will determine the final selection, yet he believes that a few general principles like the above will afford some aid to the solution of doubtful cases.

Cautiously as these statements are guarded they seem even then too general to be safe guides, and this was the general drift of the discussion which followed.

The evening of Friday was devoted to the annual banquet, which was both well and ill managed, and both a success and a failure. It was a failure in that its hour was abominably late. Although set for 8 P. M., it was not till 9:15 that the guests marched in; and not till 9:45 P. M. that the soup was reached; the banquet ending only at "midnight's holy hour." As nearly all the guests had been fasting since 1 P. M. this made a great many very uncomfortable, and the discomfort was incurred by a second innovation, that of interspersing speeches between each course; so that it was well on to 11 P. M. before the substantial courses of the dinner were reached. On the whole, the innovation was not a successful one, although by starting earlier with the dinner it perhaps might have been. On the other hand, the attendance was large, the toasts bright and well selected (for which Mr. WM. H. WILEY deserves the credit, we believe) and the company in remarkably good humor, considering the lateness of the hour.

Saturday morning was devoted to an excursion by rail to Bell's Gap over the famous mountain branch of the Pennsylvania R. R., a considerable number cutting this excursion in order to get a full night's sleep.

Saturday afternoon the business session was held, which it had been generally expected would be an important one, owing to the promised report of the Committee on Revision of the Constitution. That committee merely reported progress, however, and a lot of responses from the local societies on the question of "affiliation," as noted last week, and asked to be continued. The Committee on Compressive Strength of Cement and Settlement of Masonry reported that they were awaiting opportunity to use a large testing machine, and were continued. The Committees on Uniform Methods of Testing Materials used in Metallic Structures and on Standard Rail Sections also reported progress only.

A minority (of one) report from the Committee on Purity of Water Supply was referred to the Board of Direction. The Committee on Uniform Standard Time reported the preparation of a memorial to Congress as to which a ballot was lately taken. Mr. V. G. BOGUE, Chief Engineer, U. P. R. R., sent in a communication that $1,500 to $2,000 was wanted from the society to endow an "engineer's bed" in a Washington hospital, which was referred to the Board of Direction.

The Western Society of Engineers sent in a request that the national and local engineering societies appoint representatives to meet as a joint committee in Chicago next October to consider the question of holding an International Engineering Congress in Chicago in 1893. It was voted that the President appoint such representatives, and that he himself be one of them.

Considerable and somewhat amusing discussion then followed as to whether a committee of three had been appointed to meet with corresponding committees of the mechanical, mining and electrical societies, and consider a scheme of affiliation or partial union. It would occupy needless space to report the discussion in full, the gist of which was that it was a personal scheme of Mr. HENRY R. TOWNE, so far as the records of the society went, and that the Board of Direction did not deem it wise to appoint any such committee. It was with truth alleged, however, that the American Society of Mechanical Engineers had passed resolutions giving a *quasi* endorsement of the project. The meeting was in no humor to consider the matter, however, and on motion the resolutions in regard to it were laid on the table. The business meeting then adjourned and the convention reassembled.

A nominating committee to select officers for the ensuing year was then chosen by districts, as for several years past, the members present from different sections making independent nominations of one member each. The committee chosen was:

District I. New York City and vicinity, Mr. A. M. WELLINGTON. District II. New England, New York State and Canada, Gen. W. B. FRANKLIN. District III. Penna. and South Atlantic, Mr. CHAS. PAINE (Chairman). District IV. Southern and Pacific States, Mr. M. L. HOLMAN. District V. Ohio River and N. W. States, Mr. G. BOUSCAREN.

Mr. J. E. WATKINS then presented in abstract a long and valuable historical paper on "The Beginnings of Engineering," with especial reference to America. It was full of very interesting and in good part new material. Mr. C. Ph. BASSETT closed the afternoon session by presenting in abstract his paper on "Inland Sewage Disposal," with especial reference to the East Orange, N. J., works, which have been fully described in these columns.

The evening was devoted to a reception tendered to the Society by Mr. and Mrs. THEODORE N. ELY, at Altoona, to and from which guests were conveyed by a special train. The adjoining residences of Mr. ELY and Gen. Supt. PETTIT had been thrown together for the occasion by an external inclosed balcony connecting the front doors, and both houses were brilliantly and profusely decorated with flowers and electric lights, the last having been very skilfully arranged. In every respect except the weather the reception was a most enjoyable occasion. The rain fell in torrents, however, at frequent intervals.

Many members left after the reception or during Sunday. At the opening of the Monday morning session the Secretary read an abstract of a paper on "The Littoral Movements of the New Jersey Coast," with remarks on beach protection and jetty reaction by Prof. L. M. HAUPT, illustrated by maps and photographs. It discussed the subject at length under the following heads: Resultant direction of drift; predominating forces causing movement; angular wave action; reaction vs. velocity; normal scour in tidal inlets; enormous deductions; descriptions of special localities. The node: practical applications; shore protection; insular wave breakers, and reaction. The discussion was brief.

Prof. O. H. LANDRETH presented a paper on "The Electric Street Railway System of Nashville, Tenn.," in which he noted its remarkably rapid development and extension resulting from the change from mules to electricity. There are now 64 miles aggregate length of track, and over 100 cars. The overhead single trolley system was employed. The power developed was 670 nominal electrical horse power at 500 volts pressure. He described the plant, its details and operation, estimating by three different methods the total amount of power developed, and gave data of the effective power, cost of production, etc. In discussion it appeared that the operating expenses are very little increased, and the receipts are nearly doubled, both by expansion of the line and increased speed, which induces people to ride for pleasure. It was very much more economical than animal power.

In Washington, D. C., a new system is soon to be built having a main circuit and local ones with connections about 90 ft. apart. This system has given good results on a 2,000 ft. line, and is economical in construction, the cable, trolley, wires, yokes, etc., being on top of the ties and very accessible.

Prof. C. B. BRUSH then read a communication on "Water-Works," from Mr. F. E. SICKELS, which consisted mainly of a description, with illustrations, of some important machines, etc., of his construction, including a steam engine apparatus, a machine for cutting holes in pipes, a water-tight pressure regulator valve, now in use by the Kansas City Water-Works, and an air vessel for a direct acting pump, designed to secure the best possible vacuum and promote smooth working.

The secretary read a paper by Mr. N. W. EAYERS on "The Ventilation of Tunnels." The author discussed two methods of removing smoke and gases from tunnels, by natural and by mechanical means. The first operates by producing circulation by temperature and barometric differences, and does not influence short tunnels with their ends at the same levels, but where the engine acts notably as a piston. Ordinary ventilation requirements only necessitate the clearing away of smoke in a time less than the headway of trains. The Hoosac Tunnel is the most important example in this country of natural ventilation. It has a shaft over 1,000 ft. deep with connecting galleries at the center, and in winter has closed doors at the ends, and near them warming furnaces to prevent freezing of the atmospheric moisture. The St. Louis Tunnel has a ventilation stack 130 ft. high, and a fan house and fan near its center. A description was given of their duty and details and of recent anemometer tests of the circulation of the air. In America natural ventilation so far proves sufficient for the mountain tunnels. In Europe artificial ventilation is most developed in England. In the Mersey Tunnel fresh air is admitted at stations from an auxiliary parallel air tunnel, and the circulation is here, as in several other English tunnels, maintained by fans of from 30 to 40 ft. diameter. The conclusion was that successful ventilation lies chiefly in keeping smoke and gas out of the tunnel, instead of admitting and then removing it.

The secretary read by title a paper by Mr. F. A. VELSCHOW, on "The Cause of Trade Winds." Meteorological changes were explained and illustrated by charts, and the following conclusions deduced: The surface air becomes dry by resting over the large arid zone lying north and south of the equator, and is formed into cushions of dry air which are ultimately thrown westward over the surface of the oceans. By getting cooled down over the sea surface the dry air appears there as centers of high pressure which are kept up or fed by the continual flow of dry air from land, which circulates around these centers of high pressure. The trade winds in each of the five oceans are, therefore, each of them one continual current of dry surface air issuing from a dried-up land district lying to the east of them. The direction of the circulation does not depend upon the earth's rotary motion, but upon the interposition of the centers of high pressure and the corresponding dried-up land districts, the former always lying a little further from the equator than the latter.

The secretary read by title a paper by Mr. CHARLES E. EMERY on "Observations on the Forth Bridge," which had been already presented at a meeting of the Society, and abstracted by us.

Papers by Messrs. ROBERT MOORE, on "Some Experiments on Anchorage of Iron Rods in Rock;" ONWARD BATES on "Truss Bridges," and W. E. WORTHEN on "Steam Heating" had been announced, but were not presented to the convention.

The Secretary read a paper on "The Turn Table on the Main Track of the Silverton R. R. in Colorado," by Mr. C. A. GIBBS. The author described this railroad as the steepest, crookedest and best paying one in Colorado. It traverses a very rough country, and has to run over a switchback, for whose operation this turn table in the main track is necessary for the engine. The train runs by gravity both ways to the turn table.

Secretary BOGART presented a paper and drawings describing the repairing of a break in the Champlain Canal in New York. A small stone culvert with foundations some distance above bed rock, but in apparently good material, carried a little stream under the canal. At this point the vertical wall of the canal on the tow-path side suddenly gave way and was washed out by the water of a four-mile level. The break was repaired in the usual manner by a timber crib, puddled and sheet piled, but in a day or two there was another break on the opposite side of the canal, and as the ground under the culvert was evidently honeycombed, sheet piling was driven to refusal across the canal above and below the break, and in this section a timber aqueduct was built with vertical walls, wings and a puddle lining, thus bridging the treacherous culvert. In making the concrete used, stone was lacking, but was replaced by coal from a boat stranded in passing. The work was rapidly executed from materials at hand and has proved satisfactory.

The regular papers having been finished Mr. A. N. SNYDER, C. E., of the Pennsylvania R. R., gave a very interesting account of the history and construction of the South Fork dam, illustrating it with maps, profiles and blackboard diagrams. A very animated and interesting discussion followed on the failure of the dam last year and the destruction in consequence of the Pennsylvania R. R. viaduct bridge No. 6 in the Conemaugh Valley about two miles below the dam, which W. H. Brown, Chief Engineer of the Pennsylvania R. R. attributed (very erroneously, we think) to undermining and failure of one of the abutment foundations which, in compliance with State specifications, had been built on a timber platform which the rebuilding of the structure showed to have been only 4 ft. above bed rock. The probabilities appear to us to be that no foundation, however good, would have saved the structure, which was destroyed almost instantaneously by the direct impact of the waves, and this seemed to be the prevailing view among those who took part in the discussion. The report of the committee on the South Fork's dam disaster is still withheld. With this session the convention closed. Monday afternoon many of the members and guests, through the courtesy of the Pennsylvania R. R. Co., took a special train to Altoona and there visited that company's extensive shops, while others made an excursion to the site of the South Fork dam. Tuesday morning most of the Eastern members who remained returned by a special train to New York.

For most of our report of the last day's proceeding we are indebted to the courtesy of our contemporary, the *Engineering and Building Record*.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York.

Vol. XXIV. Saturday, July 12, 1890.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS

CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS

GEO. H. FROST.....BUSINESS MANAGER

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Advertising rates. 20 cents per line *agate measure. Schedule sent on request.* **Changes** *of advertisements must be in hand on Tuesday afternoon:* **New** *advertisements Wednesday afternoon:* **Transient** *advertisements not later than Thursday noon. The last pages go to press early on Friday, and we shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay*

Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty, or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

COMING TECHNICAL MEETINGS.

Civil Engineers' Society, St. Paul, Minn.—Next meeting, Aug. 4. Secy., Geo. L. Wilson, City Hall.

Engineers' Club of Kansas City, Mo.—Next meeting, Aug. 4. Secy., Kenneth Allen, 200 Baird Building.

Civil Engineers' Club, Cleveland, O.—Next meeting, Aug. 12. Secy., C. O. Palmer, 23 Cedar Ave.

Civil Engineers' Association of Kansas, Wichita Kan.—Next meeting, Aug. 13. Secy., J. C. Herring, Wichita.

Engineering Association of the Southwest, Nashville, Tenn.—Next meeting, Aug. 14. Secy., Olin H. Landreth, Vanderbilt University.

Engineers' Society of Western Pennsylvania.—Next meeting, July 15. Secy., S. M. Wickersham, Pittsburg, Pa.

American Society of Civil Engineers, New York.—Next meeting, July 16. Secy., John Bogart, 127 E. 23d St.

Engineers' Club of St. Louis, Mo.—Next meeting, July 16. Secy., W. H. Bryan, 30 South 7th St.

New York Railway Club.—Next meeting, July 17. Rooms, 113 Liberty St.

Engineers' Club of Philadelphia, Pa.—Next meeting, July 19. Secy., Howard Murphy, 1122 Girard St.

Association of Civil Engineers, Dallas, Tex.—Next meeting, Aug. 1. Secy., E. K. Smoot, Elm and Austin Sts.

Western Society of Engineers, Chicago, Ill.—Next meeting, Aug. 5. Secy., J. W. Weston, 220 La Salle St.

American Society of Railway Superintendents, Boston, Mass.—Annual meeting at New York on the day preceding the fall meeting of the General Time Convention. Secy., C. A. Hammond, 350 Atlantic Ave.

A PAPER on electric lighting for railway purposes by Mr. H. P. LEONARD, which we publish elsewhere in this issue, contains some interesting data with regard to the use of the electric light in switch and signal lamps, which deserves a careful reading. Some account of recent progress in train lighting is also given, especially of the very successful system in use on the London, Brighton & South Coast Ry. in England, where the dynamo is driven by a belt from the car axle. We are surprised to find, however, in the concluding portion of the paper, which we do not reprint, the following paragraph:

> Compared with the practice on American roads, the economy of this method of generating the current [by belting the dynamo to the car axle] is remarkable. It has been stated, however, by various authorities that it is impossible to secure even fair results in train lighting in this country where the power is supplied by the car axle, owing to the numerous curves on American roads, around which the wheels will often slide without turning the axle a single revolution, damaging belts and armatures. The experiments made here some years ago seem to corroborate these statements.

The above absurd statement as to the remarkable behavior of car wheels on curves went floating about in the columns of several reputable technical journals last fall. We called attention in our issue of Nov. 16 to its erroneous nature, and it is somewhat surprising to find it coming up again in a paper presented before a reputable technical society. Mr. LEONARD, however, goes further, even, than those who have told the story before him and adds, "Experiments made here some years ago seem to corroborate these statements." Of course, then, he can inform us when, where, and by whom the experiments were made and in what they consisted, and we trust he will do so. If car wheels are really in the habit of "sliding around curves without turning the axle a single revolution," the fact is of immense importance. We shall at once see our way clear to a great simplification in our car trucks, making them more like the common bob-sled; and by the simple device of avoiding tangents in our location we can equal the performance of the *Chemin de fer Glissant* and not have to use any water either.

THE possibility that the electric motor may replace the steam locomotive on ordinary railways is discussed elsewhere in this issue by several experts who show about as much agreement as might be expected in the discussion of a subject in which the lack of accurate data on almost every point makes the whole question uncertain. The topic is one of much interest, and, if we accept the views of one party to the discussion, will soon be of enormous practical importance.

Space does not permit any editorial discussion of the problem at the present time; but in criticising the papers and discussions presented elsewhere it must occur to any practical railway man that one crucial point which must be met at the outset and to which little reference is made is the difficulties which will arise if motors dependent on a line circuit of any sort replace the present independent motors. "To err is human," says the proverb, and in like manner it may be stated that all mechanisms are liable to accident or failure. The wire circuit of an electric railway and the machinery at the central stations are mechanisms which are liable to failure, and their failure must of necessity stop traffic on the whole line. It is true that by duplication of machinery and exceeding care in construction the liability to failure of the line circuit may be greatly lessened, but it cannot be entirely obviated.

THERE are other difficulties arising from the substitution of the line circuit for the independent motor, which will have to be met. Take, for instance, the handling of cars on switches, sidings and short spur lines. To devise a practical method for this may give our electrical friends some trouble, and when it comes to operating a complicated system of tracks in a crowded yard, it seems plain that resort must be had to the storage battery or the steam motor.

Again, a chief claim for the electric motor, which, however, is earnestly disputed by competent authorities, is its economy over steam. Supposing this economy to be proved for equal amounts of power, it is to be remembered that with independent motors power can be concentrated on any division or section, as it is needed. It will certainly then require a considerable additional power at the electric central station to make sure that each division shall have power enough to handle all the trains which may be concentrated upon it. These and other primary difficulties should not be ignored in discussions of the electrical railway's future; for unless they can be satisfactorily met, discussions of relative economy are of little account.

THE official inquiry into the *City of Paris* disaster has thrown very little light upon its causes, and the final judgment of the Court is on the whole a rather weak document. It finds the primary cause of the casualty to have been

> The extraordinary wearing down of the ring in the bracket which supported the extreme end of the propeller shaft, by which the end had dropped from its proper position about 7 ins. . . This probably produced a rupture of the external surfaces, gradually extending inward, and finally a total fracture.
>
> "The engines, thus relieved from all resistance beyond the friction of their own moving parts, would almost instantaneously acquire great velocity, probably sufficient to stretch the various connections until there was no clearance between the piston and cylinder cover of the low-pressure engine. The cover was struck by the piston and broken off, the piston probably broken up in the act, the cylinder torn asunder, the condenser seriously broken, and the destruction of the various other parts rapidly accomplished.

Yet, notwithstanding this, the Court states as its opinion that the propeller shafts were sufficiently supported, the after bracket was properly constructed, the bushes were of suitable material—in short, that everything in connection with the parts where it believes failure to have begun was in every way properly made and managed.

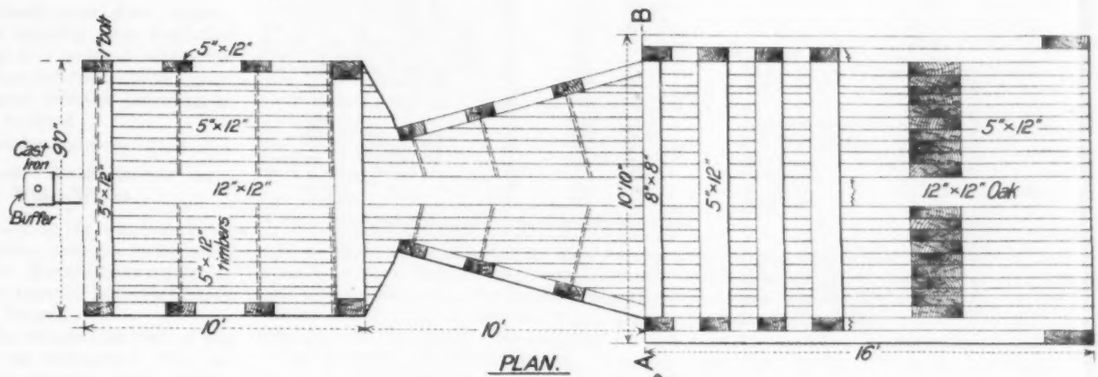
SUCH a finding is on its face absurd. If the Court is right as to the primary cause, then the construction of the parts which failed ought to be such as to avoid such accidents. The Court's sage remark, "the wearing of the after-bearing was of an abnormal character and of infrequent occurrence," reminds one of the classical verdicts of a coroner's jury. The report is largely devoted, indeed, to a laudation of the *City of Paris*, which, it says, "has proved herself to be one of the finest and safest vessels in the mercantile marine." The Court, in brief, seems to have been very much afraid of finding fault with the vessel or saying anything to hurt the feelings or the purses of either the builders or owners.

Of course, no one doubts the high character of either of these firms, or that each intended to do all that skill and expense could do to insure safety as well as speed in the vessel; but the question still remains, What caused the disaster, and how can such disasters be averted in future? It is pretty certain that mechanical engineers and naval constructors have learned lessons from the accident which are not mentioned in the Court's finding. More care will undoubtedly be taken in the construction and lining of outboard bearings, but a good deal of extra attention will also be paid to cylinders and pistons and their connections.

OF our two principal English contemporaries, *Engineering* agrees with the Court's finding, since it corresponds with the theory originally advanced by that journal. *The Engineer*, however, finds the judgment "exceedingly unsatisfactory," especially as to the original cause of the disaster, and says:

> It is a remarkable circumstance that every one quietly assumed that the piston was sufficiently strong. . . . The great low-pressure piston, a flat cone with a heavy rim, could scarcely have escaped heavy initial stress in it. . . . Nothing has been adduced to prove that the engines broke down by racing, or to contradict the theory that something gave way in the engine room and blocked the after crank, when the momentum of the propeller broke the shaft.

These conclusions are exactly in accord with



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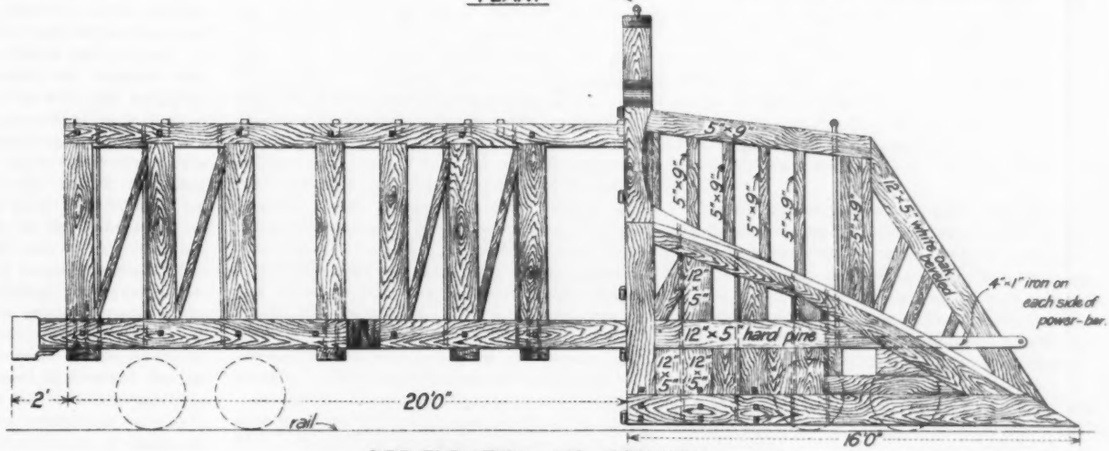

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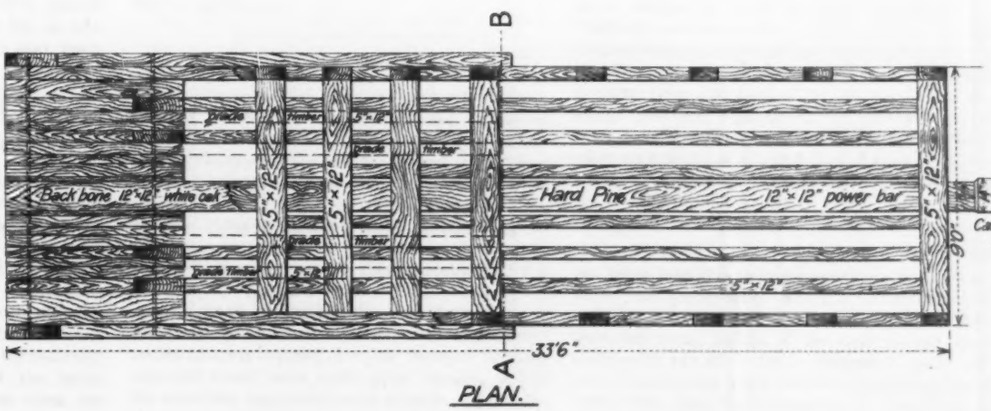

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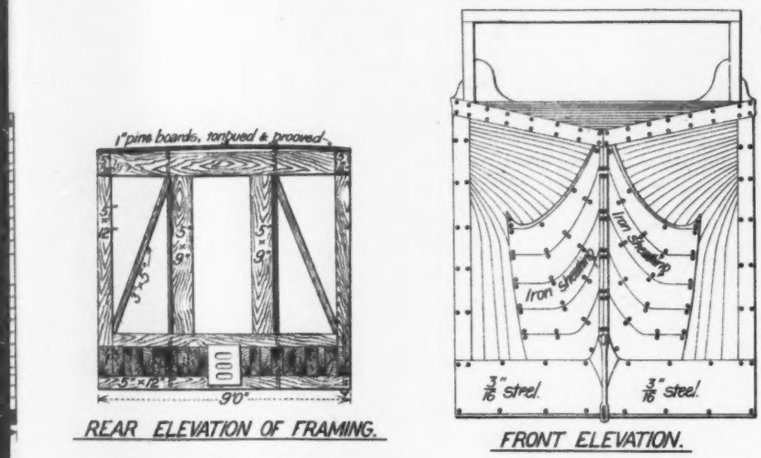

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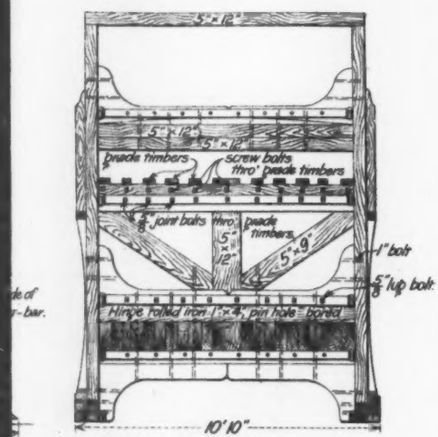

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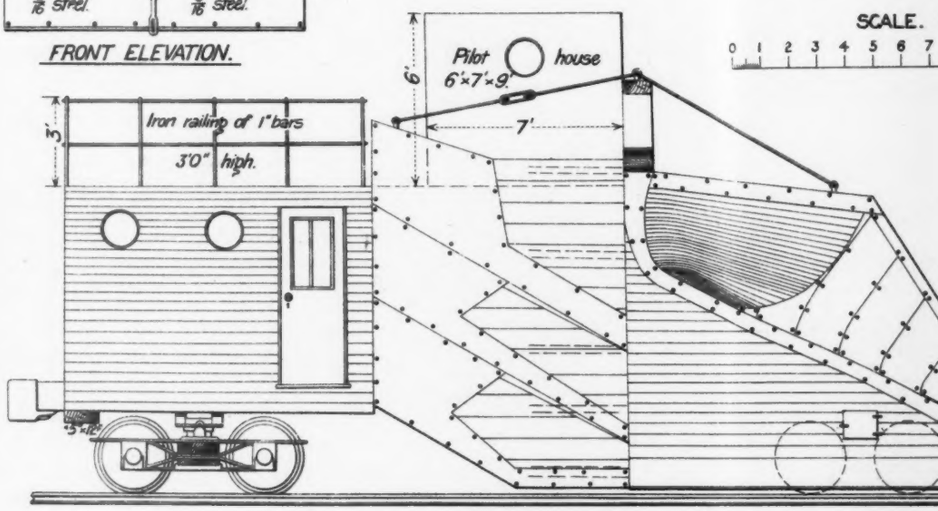
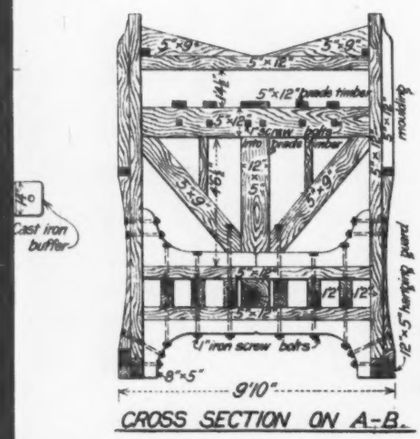


SIDE ELEVATION.

THE RUSSELL "WING ELEVATOR".



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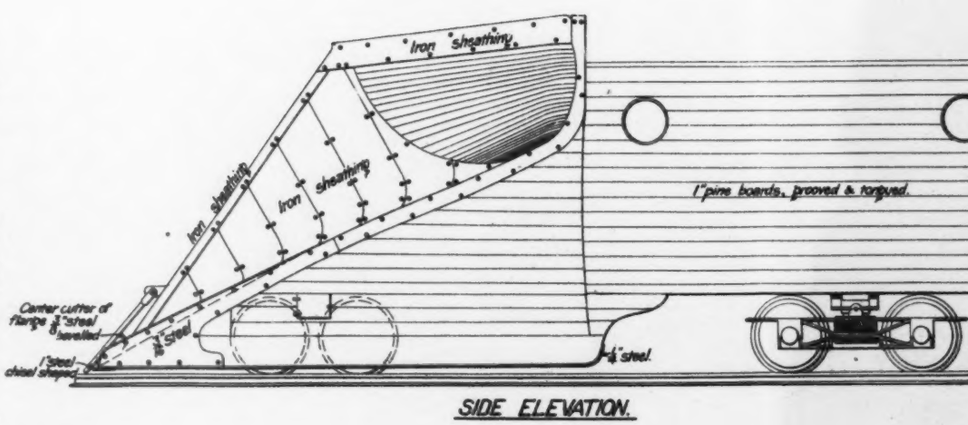

SIDE ELEVATION.

THE RUSSELL CONCAVE SNOW PLOW.

SNOW PLOWS, INTERCOLONIAL RAILWAY.

P. S. ARCHIBALD, CHIEF ENGINEER.

SCALE.

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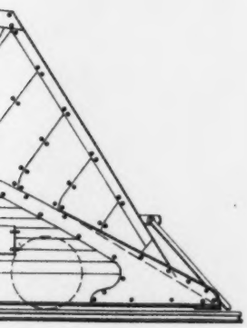

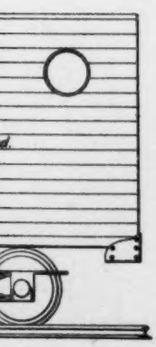

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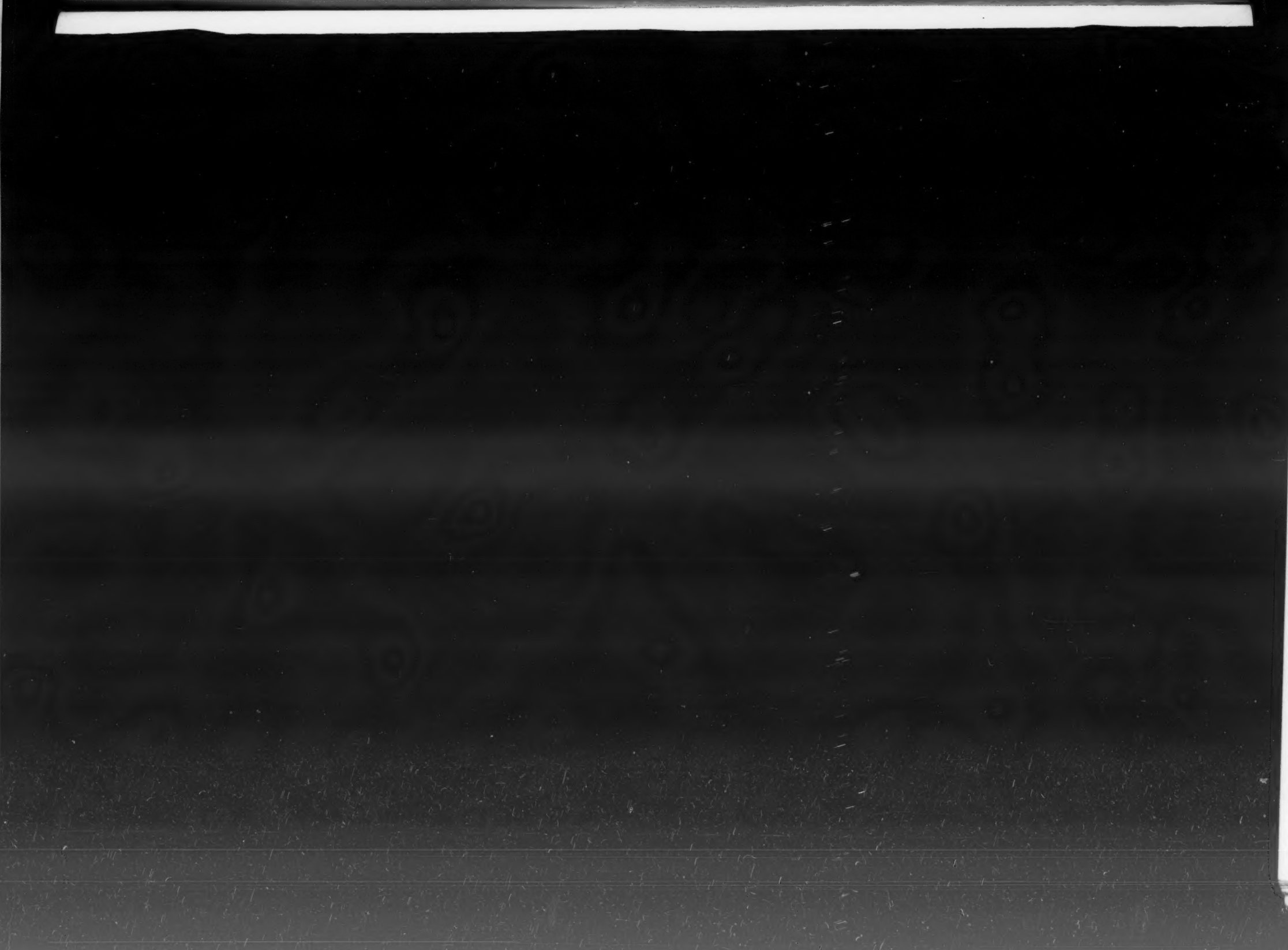


those reached by Mr. ROBERT GILLHAM, who closely inspected the engines immediately before and after the disaster, as given in two letters to this journal, published April 26 and May 10, and, it seems to us, are the only reasonable ones. How an engine could so suddenly break down, without the slightest previous warning, from a gradual wearing of a bearing is a question which the Court judiciously ignores; but it seems to us a question incapable of answer without destroying its accepted theory of the accident.

Dams and Reservoir Embankments for American Water-Works.

We continue our review of the water-works of the country by abstracting from the forthcoming MANUAL OF AMERICAN WATER-WORKS data regarding the dams and reservoir embankments in the United States and Canada.

Immediately after the failure, last year, of the South Forks dam, near Johnstown, Pa., we began making a special effort to collect descriptions and illustrations of the water-works dams and reservoirs of the United States and Canada A large number of responses to our requests were made, and this data, together with that published in the MANUAL for 1888 has enabled us to give in this year's issue full descriptions, often illustrated, of many of the dams and reservoirs of the country and more or less matter regarding hundreds of others. We have thus brought together more information on this branch of engineering, we think it is safe to say, than has ever before been published in one volume. While we have some data regarding nearly every dam or reservoir built for water supply purposes in the United States and Canada, our descriptions of many are still lacking in some details, owing to the failure of those addressed to forward the information. We therefore take this opportunity to request from engineers and contractors, who have not already done so, full descriptions of dams and reservoirs with which they have been connected in any way, and the same from water-works officials regarding such structures of this class as may form a part of their respective works. Blank forms, convenient for such descriptions, will be sent to any one on application.

Until our data is still more complete it seems best not to make any extensive studies of these structures collectively; but as a matter of general interest we give below a summary, as far as now known, of the height of existing dams and reservoir embankments:

Height.	No.	Height.	No.	Height.	No.
3-10 ft.	112	51-60 ft.	5	115 ft.	1
11-20 "	270	61-70 "	3	119 "	2
21-30 "	119	71-80 "	2		
31-40 "	35	81-90 "	0	Grand total.	566
41-50 "	13	91-100"	3		

It should be remembered that this total is somewhat below the total number of dams and reservoirs in the United States and Canada, and described in the MANUAL, as only those are included whose heights are known. Also that the heights given are always, so far as could be ascertained, from the natural surface of the ground to the top of the structure, for dams, and from the foot of the inner slope to the top of the bank for reservoir embankments. The full heights of the latter could not always be ascertained, as often the depth of water in reservoir was the only dimension given. The above heights would therefore be somewhat increased if fully reported.

The number of these structures above various heights is as follows:

Above	Above	Above	Above
100 ft., 3	70 ft., 8	40 ft., 29	10 ft., 454
90 " 6	60 " 11	30 " 64	3 " 566
80 " 6	50 " 16	20 " 183	

It will be seen that there are very few dams above 40 ft. high: but 183 out of 566, or 32.3 per cent., are above 20 ft. in height, and it may be added that there are 58 dams 20 ft. in height.

There are 14 dams 60 ft. or more in height. Their names and some of their main characteristics are:

Name and Location.	Height in ft.	Extreme length in ft.	Material.	Heart-wall.
Eden Park, Cincinnati, O.	119	1,251	Masonry	.....
Druid Lake, Baltimore, Md	119	Not given	Earth	Puddle.
San Mateo, San Francisco, Cal.	115	400	Concrete	.....
Sweetwater, National City, Cal.	98.5	360	Masonry	.....
Pilarcitos, San Francisco, Cal	95	640	Earth	None.
San Andreas, San Francisco, Cal.	93	640	Earth	None
Lake Chabot Oakland, Cal.	80	300	Earth	Not given.
Boyd's Corners, N. Y. City	78*	670	Masonry and Concrete	.....
Middle Branch " "	73	740	Earth	Rubble masonry
—— Amsterdam, N.Y.	65	416	Earth	Rubble masonry
Bear Valley, Redland, Cal.	64	300	Masonry	.....
Kauffman, Pottsville, Pa.	61	900	Earth	Not given.
No. 2, Oneonta, N. Y.	60	...	Earth	Masonry.
—— Owego "	60	250	Earth	Masonry.
—— Waverly "	60	922	Earth	Masonry.

* From rock foundation; about 55 ft. from natural surface.

To the above should be added the dam forming Basin No. 4 of the Boston water-works, and that now under construction for Basin No. 5, both of which are 60 ft. in height, and have been reported to us since the last MANUAL was compiled.

This list includes 10 earth dams, three masonry, one masonry and concrete, or concrete faced with cut masonry, one wholly of concrete. Of the earth dams one has a heart-wall of puddle, five have heart-walls of masonry, two have none, and the material of the remaining two is not given. The two earth dams without heart-walls, respectively 95 and 93 ft. high, have puddle-filled trenches beneath them, carried from the natural surface to solid rock, 26 ft. in the first and 47 ft. in the second instance. The Sweetwater, Bear Valley and Amsterdam dams are of the curved type, in plan.

As would be expected, considerably more than half of the dams and reservoirs under consideration are in the New England and Middle States. The Pacific States have a fair proportion, but the data for this section, and the whole West, is more incomplete than for the rest of the country, and, therefore, exact inferences cannot be deduced.

Among the dams or embankments 20 ft. high or over there are 32 of stone masonry; ten of these are 20 ft. in height, ten, 21 to 30 ft.; nine, 31 to 40 ft.; one each, 64, 98.5 and 119 ft. The last three are described in more detail above, together with a stone and concrete dam 78 ft. high, from the foundation, and a concrete dam 115 ft. high. We also have records of four brick reservoirs, one 21, one 26 and two 30 ft. deep, and of a timber dam at Bangor, Me., 35 ft. high. Among the lesser structures there are several timber dams, and quite a number are built of masonry.

The Laws of Air Resistance.

We print in another column another letter from General HAZEN under the above head, taking issue with us in regard to the test method of determining the laws of air resistance, and expressing an earnest desire to make some experiments with a locomotive and three loaded flat cars over two or three miles of straight track; undertaking to make the experiments at his own cost if any railway will agree to "operate this combination" for a few days. We have no doubt some valuable results might be obtained in this way if the range in areas exposed, form of areas exposed, and distribution of areas exposed (*i. e.*, as between latticed and solid areas) were made great enough, and if the recording apparatus were suitable for obtaining accurate records, the last being a very important "if." If General HAZEN or any one is prepared to go into a series of tests of this kind, we undertake without hesitation to find some road which will give them the use of the necessary track, locomotives and cars; but tests directed to some *one* branch of the air resistance problem only, as, for instance, whether it varies as V or V^2, have not sufficient of the practical about them to make it easy to obtain such facilities.

But while we are reluctant to differ from Prof. HAZEN on any question, and still more reluctant to say anything which may discourage railways from affording the facilities for experiments desired, and which would be very likely to shed some light on an obscure question; yet in the interest of scientific truth we are compelled to say (as we did in our editorial of last week), that in our judgment he greatly overrates the value of the results which he would obtain from his locomotive and train, while it is quite certain that nothing can be more erroneous than the view that gravity tests by dropping cars down a known grade or dropping bodies through known heights, and observing the velocities acquired, has any element of difficulty or doubt about it except the single one of insuring that the conditions are what they seem to be, and that the records are accurately taken. That NEWTON or PIOBERT failed in some partial tests is nothing to the purpose; NEWTON lacked the aid of electricity for determining velocities, without which the method can only give rude approximations. PIOBERT evidently had some grave defect in his apparatus, like lack of provisions to ensure verticality of fall, or of provisions to observe and record intermediate as well as total times of fall.

To show how entirely simple and certain are the "indirect methods" which General HAZEN thinks are so hopeless of good results, and how much more delicate (and also more simple) they are than any of the direct weighing methods, it may not be amiss, before leaving this subject, to outline the full theory and practice of using them; which may lead some one not yet interested to undertake experiments.

A body of any weight or form allowed to fall freely and vertically from an elevation is acted on by a constant or "uniformly accelerating" force W which we call its weight. In falling N feet W N foot-pounds of energy are communicated to the body. If the body were falling *in vacuo* we know to a thousandth of a second (and less) how long a body will take to fall under these conditions through the distance N. We also know from the same simple and well-known formulas just what velocity a body will acquire in falling through any other distance N^1 under the same conditions. If, therefore, we observe the final velocity of a body falling through the air from a height N, and find that its velocity is not that due to that fall, but to a fall *in vacuo* from a less height N^1, we know with absolute precision that $(N-N^1)W$ foot-pounds of work have been destroyed by the atmospheric or other resistances, and hence that the *average* resistance in pounds during the whole fall was

$$\frac{(N-N^1)W}{N}.$$

This by itself does not help us much, for we do not know how this average resistance was distributed; and, moreover, there is a difficulty in determining just what the final velocity was. But even this would suffice if the experiments were sufficiently extended, for by dropping many different bodies from many different heights we could collect the data for formulating a law, though with much difficulty.

But suppose that, dropping our various bodies from a height, say, of 250 ft.; insuring that they fall vertically by guide wires; reducing the friction therefrom to insignificance by careful lubricating, and checking against the effect of sudden gusts of wind both by experimenting on calm days only and by dropping a constant area and weight before and after every test, we determine electrically the time occupied in passing over every successive 30 to 50 ft. of this fall to hundredths of a second, as we very readily can by existing or improvised apparatus. We then have the

means of determining precisely the *average* velocity in passing over these spaces, which we may designate as *O*-1, 1-2, 2-3, etc., and from this average velocity we can very readily determine what should be the initial and terminal velocities in passing the successive stations 0 (starting point) 1, 2, 3, etc., as follows:

If any body be descending freely by its own weight, its velocity at any instant is directly as the square root of the space fallen through. Consequently, if we have a number of equidistant points, 1, 2, 3, 4, etc., along the path of such a body, starting from a point 0, where the body begins to fall, the velocity at 1 will $= \sqrt{\frac{1}{2}}$ of that at 2; the velocity at 2 will $= \sqrt{\frac{2}{1}}$ of that at 1; the velocity at 3 will $= \sqrt{\frac{3}{2}}$ of that at 2, and $= \sqrt{\frac{3}{4}}$ of that at 4, etc., etc.

Moreover, the *average* velocity (V_a) between any two stations on the path of such a body, if it be acted upon by a uniform accelerating force, is always equal to the half sum of the initial and terminal velocities at those stations. Then from these data we have, for the velocities at 1 and 2:

$$V_1 = 2\,V_a - V_2 = \sqrt{\frac{1}{2}}\,V_a$$

Thence
$$V_2 = \frac{2\,V_a}{1+\sqrt{\frac{1}{2}}}$$

and
$$V_1 = \frac{2\,V_a}{1+\sqrt{\frac{2}{1}}}$$

and similarly for any other two points in the path of the descending body.

These two latter formulas are not strictly correct when applied to the motion of a body falling through air, because the accelerating force is then not uniform, the continually increasing resistance of the air leaving a continually decreasing excess of accelerating force. But the error in practice is small. If the formulas were strictly correct it is obvious that the *terminal* velocity computed for any one station, as 2, from the average velocity between 1 and 2, would correspond with the *initial* velocity at the same station as deduced from the next following average velocity, between 2 and 3. In practice these two determinations of a single velocity are not quite the same, but differ by a slight, nearly constant, amount, and an average between them is taken. If deemed worth while (which it is not) even this slight source of error may be eliminated by a little more complex mathematical process which we will not go into here.

As thus determined, the actual velocity of motion in passing each successive point in the path of descent is known with great minuteness, and this given, it is mere child's play to determine what the actual resistance to the body in pounds was between the successive stations. Thus, at station 1 we will assume the actual fall of the body to have been 30 ft., and at station 2, 60 ft., and we will assume that the observed velocities in passing those points to correspond to free falls *in vacuo* of 28 and 55 ft., respectively. Then it needs no words to prove to any one with a trifling knowledge of physics that the difference is due to the loss from air resistance, and that the average air resistance in pounds $= \frac{30-28}{30}\,W = \frac{1}{15}\,W$, in the first instance, and $= \frac{30-(55-28)}{30}\,W = \frac{1}{10}\,W$ in the second instance.

The sources of error in this process are practically *nil*. The amount of energy applied is known absolutely. The force unconsumed by resistances, but taking the form of velocity, is also known absolutely, barring errors of observation, hence the difference which is consumed by resistances is also known absolutely, barring the same errors.

To speak of a process so certain and simple as this, as General HAZEN does in another column, is, if he will pardon us, absurd. In comparison with the acceleration of gravity the acceleration of a locomotive is clumsy and unmanageable; and, hence, the efforts so far made to determine air resistance laws by its aid (which have been not a few) have been anything but successful. As for the "gravity method" by dropping cars down a grade, that method in its substance is identical with the vertical drop method, and has the same advantages. Either, we believe, is amply capable of developing the true laws of air resistance in skillful hands. We cannot but hope that the considerable space, which the question of air resistance has taken up in these columns lately, may lead some competent person to undertake to determine them.

CORRESPONDENCE.

Safe Load for Piles.

TUCKAHOE, N. J., July 4, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In your issue of Oct. 19, 1889, page 369, you give safe load for pile sinking 0.1 under a blow from a 2,000 lb. hammer falling 30 ft. by formula $L = \frac{2\,w\,h}{S+1}$ as 54,545.

If I understand the formula, I get just twice that load, viz., $\frac{2\times 2{,}000\times 30}{0.1+1} = 109{,}090$. Please let me know whether I am correct. C. O. V.

[The result as given by us is correct and as computed by our correspondent incorrect; for the reason that the penetration under last blow (*s*) is specifically stated to be given in inches and not in feet. If, therefore, he makes the correct substitution his equation will read

$$L = \frac{2\,w\,h}{S+1} = \frac{2\times 2{,}000\times 30}{1.2\times 1} + 54{,}545$$

In the formula, as stated, L = safe load in pounds *or any other* unit of weight, w = weight of hammer in the same unit, h = height of last fall in feet and S = last penetration in inches, assumed to have been reasonably uniform. A pile which is safe by this formula, so far as we can learn, will be safe everywhere, and under all conditions of reasonable service; a pile which is not safe by this formula may fail in service; if loaded with very much more they will be quite likely to fail.—ED. ENG. NEWS.]

A Catenarian Problem.

KANSAS CITY, MO., July 1, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: You will please demonstrate the following problem and confer a favor on a constant reader of your very valuable journal.

A wire cable 2½ ins. in diameter is suspended from two points 3,000 ft. apart, and at the center of it is suspended a load of 10 tons. What will the tensile strain be at the points of support to bring the sag at center to a point 40 ft. below the two points of support, assuming the latter to be at the same level. P. L.

[We pass this problem along to any of our readers who choose to take it up and answer it. It is simple enough, and but one answer can be published.—ED. ENG. NEWS.]

The Laws of Air Resistance.

NEW YORK, July 5, 1890.

TO THE EDITOR OF ENGINEERING NEWS.

SIR: Referring to your excellent criticism of my recent paper on Atmospheric Resistance,* permit me to make an explanation and a suggestion.

The application to an ordinary railway train of any formula giving air resistance per unit area, is of very uncertain accuracy. At what distance apart should each car end be taken as presenting its whole surface to the full pressure due to velocity? At the given distance apart what is the proper reducing coefficient due to the partial covering of each car by that in front of it? What value shall be given to all the irregularities of window framing, brake-rods, wheels, axles, etc.? To answer these questions, two things, not yet accomplished, must be effected. First, the obtainment of a reliable pressure indicator. Second, the application of such indicator to many points throughout a train.

In the comparative calculations that appeared in the paper above mentioned, I made an estimate (defined by somebody as an "educated guess") of the effective areas of the cars following the first. The figures used seemed to me well within the proper mark. But because there is no certain rule to guide, I am well aware that these comparisons are only rough illustrations of the differences between the resistance formula presented by me and those heretofore in vogue.

The suggestion I want to make is as to the best method of getting a sort of Supreme Court decision *in re* atmospheric resistance.

Let some good observer be given the privilege of the Eiffel Tower, the Washington Monument or other tall structure; from a convenient point drop guide wires; along these let fall objects varying widely in size, shape and weight; arrange a chronograph which shall electrically record the transit of the falling object past a number of fixed points which divide the path into, say, 50-ft. sections. The data thus obtainable will be of a high order of accuracy; the theoretical relations guiding the inquiry are simple; the results could scarcely fail to be reliable.

If NEWTON, who tried the gravity method, had had an Eiffel Tower and an electric chronograph, I think the present confusion in this matter would be good order.

This method, it seems to me, would be more accurate than that suggested by you, of dropping flat cars, carrying resisting surfaces, down a known grade.

It is to be hoped that one of these two methods—or some better one—will ere long be thoroughly tested.

O. T. CROSBY.

[The suggestion we regard as an excellent one, with the proviso that the guide wires should be at such a distance from all parts of the structure as to insure that the body tested is actually falling through unobstructed air, and that a body of constant weight and area shall be dropped before and after each test in order to be sure that there were no wind currents to disturb the accuracy of the test. ED. ENG. NEWS.]

The Laws of Air Resistance.

WASHINGTON, D. C., July 7, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Please accept my thanks for setting forth my views on "Air Resistance" in your issue of July 5. You think that a railway can be found which will furnish facilities for experiments on air resistance. I am in some doubt about this, but I presume my failure in interesting railways was due to a faulty presentation of the subject, and also due to the fact that I have had no backing and have not been known. Certain it is that I obtained a positive refusal from the Pennsylvania R. R. and a partial permission to use an engine in front of a regular train by the Baltimore & Ohio. What is needed is two or three miles of straightaway track, an engine and three flat-bottomed cars loaded with old rails to steady the motion. If any railway will agree to operate such a combination a few days, I will agree to perform the experiments, paying my own expenses. I have had several months' experience directly in this line of work. It would also be very important to have Mr. CROSBY associated in the experiments to propose new lines of investigation and to check the work as it went along.

As to measuring "Air Resistance" by noting the velocity of a car on a down grade without and with plates, I think a moment's reflection will show its unfeasibility. Of course you could not calculate from the difference in velocity in the two cases the pressure in pounds on the plate, for that is just what we want to measure. [Of course it could be done, and with extreme delicacy.—ED.] The only feasible method would be to apply a known weight or pressure in pounds to the running car before the plate was put on, in order to find how many pounds pressure against the car would be required to diminish the velocity the same amount that the plate did. This of course would be practically impossible. If gravity cars will run any more smoothly than cars pushed by a locomotive, of course the pressure against the plate could be determined in that way as well as in the other.

As to measuring this resistance by dropping plates from a height, I may say that this plan was carried out by Sir ISAAC NEWTON in the 18th century. He dropped distended bladders in St. Paul's cathedral. It was also tried by PROBERT in France, who used a plate of 10.76 sq. ft. (1 sq. metre) and determined the velocity of fall electrically. The results were far from satisfactory, though they proved that the resistance varied with the square of the velocity. This method complicates the problem terribly, and introduces unknown elements into the problem, which is exceedingly complex in itself, and cannot be simplified too much. If this resistance cannot be measured directly upon the plate, we may be very certain it can never be measured indirectly. I have had little difficulty in measuring the resistance with a whirling arm of 10 ft. at velocities less than four miles per hour, and I think there ought to be much less difficulty in making the measurement on a straightaway track at 60 miles per hour. Moreover, I could not use plates more than 2 ft. square while on the

*ENGINEERING NEWS, May 31, June 14, 1890. Criticism, June 21, 1890. The paper in full appeared in London *Engineering*, May 3 to June 13, 1890.

car. I think a plate 10 and perhaps 12 ft. square might be used. I shall be most happy to correspond with any railway which will take up this question.

H. A. HAZEN.

Notes and Queries.

James Kay, of 23 Normand St., Montreal, Can., wants the address of manufacturers of wire fence machinery, as he proposes to engage in the manufacture of such fencing.

Electric Lighting in the Railroad Service.*

For many years one of the most prolific sources of injury to railroad men and loss to the company has been the switching of cars in the yards at night, with only a hand lantern to indicate the movements required. The engineer, owing to the darkness, was obliged frequently to depend more on luck than otherwise to guide him in handling his engine, the result being often a crushed hand or shoulder for the brakeman, if he escaped being caught between the bumpers; or the engineer miscalculating his distance in the darkness, would come back too hard, and thereby break the drawheads and smash in the ends of the cars.

The introduction of the arc light in the large yards where a great deal of switching or making up of trains at night is performed was found to work a wonderful improvement in this direction, and now there is scarcely a railroad from the Atlantic to the Pacific which does not use the electric light in its important yards.

It enables yard and engine men to see one another almost as clearly as in sunlight, and in addition to preventing accidents, permits the work to be done with almost as much dispatch as during daylight.

An extended inquiry among the men using these lights develops the general belief that they pay for themselves several times over in the single item of repairs saved to rolling stock.

Other important features in the use of the electric arc lamp are the greater amount of loading or unloading of cars that can be carried on at night, than with the oil lamp system, and the reduction of the number of car robberies and shortages in freight packages.

The author instanced the experience of the Chesapeake & Ohio Ry. at the Newport News terminus. The New York steamers generally arrive at night, and under the old oil-lamp system it was found impossible to get the freight billed and cars loaded and started within less than 12 to 14 hours after the steamer's arrival. The number of claims for shortage and damage were very great, and reports of freight astray were numerous.

A 50-arc plant was put up and the piers were all brilliantly lit. As a result trains were forwarded in one-half the time formerly required, and shortage and damage claims began at once to diminish. The coal piers were also lit up, enabling the coaling of steamships to proceed as rapidly by night as by day.

In examining the systems in use, it is found that the Thomson Houston and the Brush are most preferred, though the Western Electric and the Jenney are very popular in the West, while the new alternating system of arc lighting of the Westinghouse Company, owing to the greater life of the carbon, is making rapid strides.

A new and important improvement has recently been made in arc lamps, which results in an enormous increase in the luminosity of the arc, and consequently a most brilliant and economical light.

This has been effected by making the lower carbon hollow and fitting it with a reservoir of oil and a wick; the oil ascending the wick by capillary attraction is converted into carbon vapor by the heat of the electric arc, reinforcing the light of the arc by luminous particles of incandescent carbon, thereby increasing its brilliancy. The tests of this lamp recently made by Dr. HOPKINSON, of London, show that the efficiency of the arc in watts per candle is nearly doubled, the color of the light being changed to a clear yellowish white, while the increased cost of the hollow carbon and the oil is so small that it is not worth mentioning, a single drop of the oil lasting nearly a minute. It is claimed for this new lamp that it reduces the cost of arc lighting to such an extent that it is equal to gas at 10 cents per 1,000 ft.

ELECTRIC LOCOMOTIVE HEADLIGHTS.

For several years experiments have been carried on with the view to adapting the arc light for use in the headlights of locomotives. It was quickly ascertained however, that the constant vibration of the locomotive seriously affected the feeding mechanism of the lamp, and consequently the brilliancy of the arc; but recently the improved feed apparatus and the adoption of a copper negative pencil, instead of the carbon hitherto used, have been found to eliminate the difficulties, and the National Electric Locomotive Headlight Co., of Indianapolis, is now ready to furnish headlights of this description, the current being generated by a small combined dynamo and engine, carried on the locomotive. The engine is about 3 H. P., and has 4 cylinders. It weighs about 700 pounds, with the dynamo, which is about 2,000 watts capacity, and is placed over the smoke arch of the locomotive between the headlight and the smoke-stack.

The trials of this apparatus made last November on the Vandalia Line showed that on very dark and rainy nights the fences to the cattle guards could be seen ¾ of a mile away; a light-colored car would show as an obstruction on the track at about that distance. At 800 ft., a tie at the side of the track would be plainly seen. Horses and cattle showed up clearly 1,000 ft. ahead, and the colors on a switch target could be seen a quarter of a mile distant.

This shows that any serious obtructions on the track, except in case of very thick fog could be plainly distinguished far enough ahead to stop an air-braked train traveling at a speed af 45 miles per hour.

Another method has been experimented with to some extent, in which groups of incandescent lamps are placed in the headlight. This has given good results, but the beam of light is not as penetrating as when the arc is used, and the carbon filaments in the lamps are soon broken on account of the vibration of the locomotive.

THE ELECTRIC LIGHT IN SWITCH STANDS.

On May 30, 1887, the Southern Pacific Ry. Co., finding it difficult to keep the oil lamps lighted in the interlocking and automatic signals in its yards at Oakland, Cal., on account of the variable draughts sweeping across the bay, decided as an experiment to light 12 of these lamps from its electric light circuit, wiring the lamps in multiple.

So satisfactory were the results, that the number of signals so lighted has been increased gradually until 134 lamps in the interlocking and automatic signals, switch stands, switch lights and signal towers there are now lighted by electricity. Thirty-one of these lamps are in switches and signals that have underground wire connections, 16 of them light up 4 signal towers, while the balance are in signals located on posts and connected by overhead wires, all being supplied by an arc light dynamo owned and operated by the company.

The signal lamps are 38-volt, and are wired from 10 to 15 in multiple according to the number of signals within convenient distance to form a group, so reducing the E. M. F. that the lamps use only from 20 to 28 volts pressure, thus lengthening their life and yet giving sufficient amount of light to illuminate the bull's-eye lens of the lantern.

The lamps complete, including case, base, lens, socket and lamp, cost about $2 each, as compared with about $5 each for the oil lamp complete, which lasted on an average of only two years. The lamps first installed over three years ago are still in use and have required no other care or attention than renewing the underground wire to two of them.

I am informed by Mr. SLATER, the Master of Signals for the Southern Pacific Co., to whom I am indebted for many of these details, that the actual expense for the installation and maintenance of these lights beyond the interest on first cost for wire, lamps, and fixtures, etc., is very small, the additional amount of power required for the signal lamps being only about 5 H. P. In the system of accounting in use on the Southern Pacific Ry. $90 per month is the proportion charged to the signal lights.

The details of this system have been so well worked out at Oakland that there seems but little room left for improvement, save that it might be well to have the lanterns made large enough to contain two lamps so arranged that one is automatically lighted on the extinction or destruction from any cause of the other. This feature has been adopted by the Edison Company for side lights of ocean or river steamers lighted by electricity, where it is extremely important to keep the lamp constantly burning at night.

The above mentioned plant seems to be the only one thus far installed on so large a scale, and the results obtained evidence a large economy as against the use of the oil lamp for this purpose, where a railroad company owns and operates its own electric light plant of sufficient capacity to supply the signal lamps. As an illustration, the Central R. R. of Jersey City have 45 interlocking signal lamps at their Jersey City station, which consume 5 galls. of No. 7 oil daily at 10 cents. per gall. or $15.50 per month; with the two lamp men at $40 and $45 per month, the total expense for the 45 lamps is $100.50 per month as against $90 for the 134 lamps of the Southern Pacific at Oakland, without considering the cost of breakage, the trouble from lamps blowing or bursting, which is likely to occur at Jersey City.

LIGHTING PASSENGER TRAINS.

The author referred to the able paper by Mr. CHAS. SELDEN on this topic (see ENGINEERING NEWS, Nov. 2, 1889) and gave the following additional notes on the present status of train lighting by electricity:

The Pennsylvania Co. still continues to light their parlor cars from storage batteries, using a low voltage lamp.

The Intercolonial Ry. of Canada has adopted the accumulator system alone on the trains between Halifax and Quebec, and now have more than 40 cars fitted up with electric lamps, which are of 16 c. p., and vary from 11 to 22 to a car. The accumulators are charged at four different points on the line, running about 500 miles with the one charge, and the results thus far obtained are very satisfactory. To provide for emergencies oil lamps have been retained in each car.

The combination of dynamo and storage battery, first adopted by the Pullman Co., is gradually being extended in this country, and is giving great satisfaction in the East and West, but, it appears, at a large expense for maintenance. The Chesapeake & Ohio vestibule train, running between New York and Cincinnati with six cars, is supplied with 118 lamps. Up to May 1, 1890, the average cost per lamp for maintenance and renewals was $1.10 per month.

The Chicago, Milwaukee & St. Paul Ry. have recently added to their equipment two independent light and heat tenders, which carry their own boilers for steam heating and for running a Westinghouse automatic engine, attached to a No. 4 Edison compound wound dynamo, supplying the current direct for lighting all the cars in the train, thus doing away with the dynamo on the baggage car and storage battery combination.

The results have been very favorable, and during more than six months of constant service there has not been a single failure. This company has 4 trains covering about 45 cars lighted by electricity, and expects to adopt this system of illumination on all of its through trains. It is stated that the expense of building and equipping these tenders is not much greater than the cost of the storage battery-dynamo combination, with the expensive wiring required in that system.

It is confidently believed that the cost of lighting trains by electricity in the United States can be greatly reduced by adopting the method so largely used abroad, of getting power from the axle.

Mr. HOUGHTON, the telegraph superintendent of the London, Brighton & South Coast Ry., one of the patentees of the system, advises me that there are 16 trains running on that road which are so lighted—13 of them local trains and three express; the speed of the express trains reaches 70 miles an hour, while that of the locals runs from 20 to 60 miles per hour.

The express trains are wired for an average of 70 lamps and the others 40; the candle power of these lamps varies from 8 to 16, according to the speed of the train.

The dynamo furnishing current for these lamps is placed in the baggage car, and has a pulley at each end connected by belts direct with the axles of the car. No intermediate shafting being used, the slack is taken up by loose pulleys that can be pressed upon the belts.

In the same car with the dynamo, 22 accumulators weighing about 4,000 lbs. are placed in parallel with the dynamo for use whenever the train stops.

Connected by a belt from the dynamo is a centrifugal governor which joins up the circuit at any desired speed, causing the dynamo to charge the accumulators. When the lamps are not lighted, the governor introduces resistance into the dynamo field, reducing the output to about 40 ampères, in order not to damage the accumulator plates. When, however, it is necessary to light the lamps, the dynamo generates the full current, of which about 35 ampères pass into the lamps, the balance being stored in the accumulators.

In each lamp circuit a regulator is placed in order to keep the light in the lamps at the same power, regardless of the speed of the train, and shunt any surplus current into the accumulators; so that 42-volt lamps may be used with a dynamo of any E. M. F. above that voltage without any variation in the light of the lamps.

The trains on which this system is used consist mostly of 10 cars, which run solid, that is, are not broken up, and average forty 12 c. p. lamps to a train. By using accumulators in each car, however, no difficulty would be found in splitting up at the train at various points.

The figures given by Mr. HOUGHTON show:

Total weight of the plant on each train	3 tons
Cost of plant on each train	£400
Cost of maintenance per annum	£65

The only attention given the trains is at each terminus, where one man inspects the apparatus, oils the pulley bearings, etc., before the train pulls out.

One of these trains has been running since Dec. 19, 1883, without a single failure being reported. During the first eleven months of its use it made 2,352 trips and ran 27,322 miles.

The Midland R. R. of England is running three trains lighted by electricity, and has recently fitted up two others. The dynamo is placed in the baggage car, and is also driven from the axle with about the same electrical arrangements as are used on the London & Brighton road. The short trains have 85 lamps run from one set of storage batteries in the baggage car. On one train the batteries are in series, but on the others in parallel. The latter seems to be the most satisfactory. Eight candle power lamps are used on this road, two to each compartment.

*Condensed from a paper by M. B. LEONARD, read at the Ninth Annual Meeting of the Association of Railway Telegraph Superintendents, at Niagara Falls, N. Y.

EXTENSIVE WHARVES, WAREHOUSES AND GRAIN ELEVATORS are to be built at St. John, N. B., by J. D. Leary, who is to receive from the city a subsidy of $5,000 per year for 20 years. Mr. Leary is the inventor of the log rafts, one of which, two years ago, strewed the North Atlantic with dangerous driftwood.

The Russell Snow Plow, Intercolonial Railway.

(WITH INSET.)

To the ordinary reader illustrations of snow plows may seem out of place in midsummer, when the mercury is bobbing around in the nineties and snow and ice are valuable and perishable commodities. In the railway service, however, while midwinter is the time when snow plows are required, the discussion as to what equipment is necessary to keep the road open and its trains on time during the winter months must be made long before the machines are needed. It is not at all too soon for motive power departments to canvass the question of snow plows and decide what additions, if any, are needed and can be afforded.

Illustrations of various types of rotary snow plows and controversies between rival manufacturers have of late taken up much space in technical journals, more, perhaps, than their importance justifies. Be that as it may, it will scarcely be disputed that while the rotary type of plow is a boon to railway managers in sections subject to severe storms, such as those which blocked traffic west of the Rocky Mountains last winter, there are many roads which cannot afford the investment required to purchase one, and which must keep their road open as best they can with machines of more moderate cost.

Our inset sheet in this issue shows two types of snow-plow which have been tried on the Intercolonial Ry., and have given the greatest satisfaction there for the past four years.

Probably with the exception of a few roads in the Rocky Mountains and on the Pacific slope, there are no railways which are more difficult to keep open in winter than the Intercolonial. The tests which the plow has sustained, therefore, entitle it to at least a fair examination.

It will be seen at once that the plow is of the ordinary push-plow type, and is properly called a plow (the rotary plows are more properly called excavators). The "wing elevator" plow, illustrated on the upper part of the inset sheet, is designed to overcome the wedging which has been a chief obstacle in clearing deep drifts with ordinary plows.

As seen by reference to the drawings, the front of the plow is sheathed with No. 14 sheet iron, while the cutting edge is of $\frac{3}{16}$ in. steel.

This front nose is 16 ft. in length and will clear a space 10 ft. 6 ins. in width, which, of course, is all that is needed, except when running in drifts or in exceptionally deep snow. At these places to pare off the sides of the banks at each side and throw the snow far to one side, two wing elevators are provided, hinged just back of the nose and fitted with three inclined channels, against which the snow from the nose strikes and is thrown upward and outward away from the track. These wings are 9 × 11 ft. in size, and weigh 3,500 lbs. As seen by the plan of the framing, they can be closed in against the sides of the plow when desired, and they will swing outward 3 ft. or less, as may be needed.

The pilot house on top affords shelter to the lookout, who signals to the engine driver in the locomotive at the rear, and gives orders to the men who work the wings. The plow has a total wheel base of 27½ ft., and the top of the pilot house is 16 ft. 9 ins. above the rail. It is carried on two four-wheeled trucks, and the forward trucks are made especially heavy, with journals both inside and outside the wheel. The inside journals are 4½ × 7 ins.; the outside journals are 3½ × 5 ins. The side bearings in both trucks have friction rollers 4 ins. in diameter, so that the trucks round curves easily notwithstanding their heavy load.

The plows now in use on the Intercolonial, however, shown on the lower part of the sheet, are made without the "wing elevator," though in other respects their construction is similar. Mr. P. S. ARCHIBALD, Chief Engineer of the Intercolonial, to whom we are indebted for the drawings from which our engravings are made, writes us as follows.

The Russell plow has been in use on this road since 1886 I do not attach any great importance to the peculiar shape of this plow, but its merits, in my opinion are in its great strength and its excellent workmanship. We feel safe in attaching three of our heaviest locomotives to one of them and running into heavy drifts from 5 to 15 ft. deep at a speed of from 25 to 35 miles per hour. With our ordinary push plows we dare not do this, for fear of the plow collapsing or leaving the track. We have eight in use and are about purchasing two more.

From an examination of the drawings showing the framing, it appears that the plow is indeed very solidly constructed. A novel and important feature is the heavy hard pine timber 12 × 12 ins. square and 30 ft. long, running through the center of the frame at the height of the push bar, and transmitting the strain directly to the point of greatest resistance at the nose of the plow. The "back-bone," against which the front end of this push timber bears is also 12 × 12 ins., of white oak, while the nose timber is 5 × 12 ins., of hard pine. Reference to the sectional views will show how thoroughly the structure is braced and stiffened to resist lateral strains

The cost of the "wing elevator" plow is about $3,600. The plain concave plow costs considerably less. An excavator of the rotary type costs about $15,000, and except for very rare storms, occurring on roads in severe climates perhaps once in a winter, and on most roads only once in 5 or 10 years, the push plow is the more efficient machine, being much cheaper and simpler to operate, less liable to accidents and delays and more durable. The drift which will stand the impact of three heavy locomotives and a 30 ton plow, running at 35 miles per hour, as described above by Mr. ARCHIBALD, is not at all common.

It is worth considering, indeed, whether a road is not better equipped for fighting snow when furnished with three or four plows of this type than when equipped with a single rotary. The secret of fighting snow successfully is to keep the road open. Three plows of this type, costing say $9,000, started out as soon as any storm comes beyond the capacity of the pony plows to handle, and run constantly, will keep a large mileage of track free from bad drifts, while a single plow of the rotary type, costing perhaps $15,000, could not get over the road fast enough to prevent portions of the line from being blocked.

The great trouble with the old type of push plow was the persistence with which it went into the ditch whenever it struck an especially heavy drift, and the recklessness with which seven or eight locomotives were sometimes ditched behind it. This fault seems to have been remedied in the plow illustrated, and enables the power of the locomotive to be exerted with much less danger to men or machines than in the common types of snow plow.

The inventor of these plows was Mr. J. H. RUSSELL, of St. John, N. B. Besides the Intercolonial Ry. these plows are in use on the New Brunswick Ry., and one was built last winter by the Portland Locomotive Works for the Central New England & Western Ry.

Sharpest Curves in Use.

In a paper read before the Illinois Society of Civil Engineers by Mr. E. A. HILL, is a partial list of the sharpest curves in use in this country. A further list is found on pages 325-6 of WELLINGTON'S "Economic Theory of Railway Location," including a number of the following and some not given here. All but the last are operated by locomotives and coupled cars, the last with single cars hauled by horses only.

Road.	Curve.	Place.
N. Y. Central. ...	320 to 400 ft. radius	Grand Cen. depot, N. Y.
*Pennsylvania. ..	300 " "	Centennial terminus.
Baltimore & Ohio	375 & 300 " "	Harper's Ferry.
Ches. & Ohio.	236 & 300 " "	Rockfish Gap Tunnel.
C., C., C. & St. L.	240 " "	Lafayette.
" " "	306 " "	St. Louis.
Ches. & Ohio.....	231, 210, 187 ft. radius	Cincinnati.
" "	160 ft. radius.	Indianapolis, in a lumber yard.
Den. & R. Grande	24° — 33°.....	Main track, 3 ft. gauge
" "	35° — 40°.....	Quarry track, 3 ft. gauge.
Chi., Mil. & St. P.	125 ft. radius	Minneapolis, side track
Campbell Coal Co	110 " "	Cincinnati.
Little Miami.	60 & 84.6 " "	"
N. Y. Central.....	60 " "	Centre St., New York.

* No longer used.

To the above Mr. HILL adds, very justly:

To sum up this matter of curvature it would appear that curves of at least 30° (191 ft.) can be safely used for passenger yards and that where coupled freight cars are to be handled by engines in freight yards, curves can be used with a radius as low as 90 or 100 ft., subject to occasional damage to corners of cars where trains of coupled cars are pushed over the curve, and that single freight cars can turn on a 40-ft. curve.

Machined Car Wheels.

The New York Car Wheel Works, of Buffalo, N. Y., have just issued a small pamphlet in regard to their processes of such general technical interest that we make from it the following considerable extracts:

About seven years ago we commenced making tests (chemical and physical), in a limited way, intended to give such information regarding the quality of our wheels as would enable us to conduct their manufacture on some other basis than that of obtaining a knowledge of their exact quality in service. We desired to know this before delivering them for service. These tests were finally brought to cover every wheel manufactured by us, in an individual manner. Means were taken to distinguish and identify each wheel, so that five years ago we had reached the point where every wheel made was subjected to six separate tests, giving full information of all details regarding their quality and character. Standards for inspection and acceptance were then established which would in our experience produce a safe wheel as stated. The results of this labor speak for themselves: *not one wheel delivered by us for service has ever broken*, out of over 500,000 wheels made by us during that time. The all-important question of safety was determined, all other conditions being correct, by the strength of the iron obtained from our mixtures.

For the best ordinary work this standard of strength may be expressed by a load of 2,800 lbs. required to break a bar 1 in. square by 12 ins. long, made from the mixtures of iron used in the wheels, this load of 2,800 lbs. being placed upon the center of the bar to break it. [TRAUTWINE gives for this 1,500 to 2,700, average 2,100 lbs.—ED.] A bar of this size carrying a load of 2,600 lbs. would be considered very strong ordinary iron, but as 2,800 lbs. was the best average obtained from mixtures on our first trials, that was established as the limit of strength. Our work in this field resulted in obtaining mixtures that would give a bar of the size referred to a carrying a load of 3,000 lbs. Further work resulted better; we obtained bars carrying 3,200 lbs., 3,300 lbs., and so on, step by step, up to 4,000 lbs., as a regular and positive result obtainable from certain mixtures We have lately made bars (same size) carrying a load of 5,000 lbs., but this is exceptional. Mixtures giving test bars with such extraordinary strength are not only made from the highest grades of iron, but from special lots of iron of these grades manufactured expressly for us, and which lots are subject to rejection unless they give certain results in the tests made of the iron when received.

In the effort to improve the manufacture of our wheels, attention was early drawn to the great necessity of providing some means for overcoming the mechanical imperfections. It is a well-known fact that the great majority perhaps 75%, of the wheels removed from service are taken out on account of defects arising from the use of brakes. When the brakes are applied to a wheel that is not round, the variation in pressure between the high and low places is exceedingly great, and when the brake engages the wheel at its highest point it is very apt to op and slide, it, producing a flat spot; if the wheel is not removed, after a short time the iron shells out at this point, and then it must be removed on account of its general imperfections. With perfectly true wheels the pressure of the brakes is equalized, and the braking pressure may be increased without liability to slide wheels.

Machines had been constructed for turning and grinding wheels after they were placed on axles, but the work being slow and expensive, it was found impracticable when carried to any extent; the cost of finishing wheels on them was greater than that of the labor required for their manufacture. We concluded that the wheels should be finished before being placed on axles, for the reason that each wheel could be treated for its own defects, and the work be done by the wheel maker. When wheels were finished on axles the defects in rotundity were never at the same point in both wheels, and to insure equal diameters it was necessary to grind more from one wheel than from the other. To finish wheels on the axle made it impossible for the wheel maker to do the work, as not one per cent. of the wheels used are furnished by the maker fitted in that manner.

Our process with each wheel is to bore it out in the usual manner and then to place it, by means of suitable attachments, on the self-centering mandrel of the grinding machine devised by us. When the grinding attachments are brought into position and the emery wheels properly adjusted the work of the machine is automatic until the wheel is ground true. Two wheels are placed on the machine and operated on independently, the adjustment of one being made by the attendant after the other is in position.

The average output of one machine in ten hours is 50 wheels. We have finished 60 in the same time. There is but one attendant to each machine and the work can be done by any intelligent laborer. These results have been steadily obtained for the past year.

After the wheels are removed from the grinder they are placed on the balancing machine and tested, as described below. They are then gauged to diameters by sixty fourths of an inch and are ready for service, mechanically perfect.

The advantages to be gained by the use of "machined" wheels are so apparent that it will not be necessary to dwell at length upon them. A few facts may be stated however:

They can be gauged to exact sizes. The importance of uniformity in this is best illustrated by the fact that in one mile, with a pair of wheels that vary in diameter but 1-16 in., the larger wheel will travel 9 ft. more than the smaller one, and this variation must be overcome by dragging or pulling the smaller wheel and the sliding or retarding of the larger one against the common rails.

In making 1-16 in. the basis of this comparison, we are taking the smallest possible limit that can be obtained with ordinary cast-iron car wheels and ordinary conditions under which they go into service. The Pennsylvania Railroad specifications were first drawn with the requirement that wheels should be true to 1-16 in., the test being made with an iron ring placed over them. This, however, was found impossible in practice, and was afterward changed to a possible variation of 3-32 in. As the metallic ring placed over the wheel would require at least 1-64 in. all around to admit of its being placed on and taken off, it follows that the ordinary wheel cannot be made true within 1/16 in. Boring the wheels first, and then grinding them, insures an absolutely true relation between the bore and the circumference, with all the consequent benefits as compared to a wheel the circumference of which does not bear a true relation to its center. In boring the ordinary wheel it is centered from its circumference, which, being admittedly untrue, makes it impossible to bore it to a true center. This variation in ordinary methods not only causes an eccentric motion in the wheel, but throws it out of balance. Let us suppose a train in motion at the rate of 30 miles per hour. In such a case a wheel will make 306 revolutions per minute. If it is 10 lbs. out of balance there would be a variation in the weight of metal moved through the circle described by the circumference equivalent to 3,060 lbs. per minute. There are eight wheels under a car. The total variation would be upward of 25,000 lbs. The effect of this on the cars and track can be easily estimated. Ten pounds is not a high estimate for amount out of balance as wheels are ordinarily used, for in addition to what is created by imperfect fitting we must consider the unequal distribution of metal in the wheel consequent on the conditions of foundry practice. A casting weighing a quarter of a ton cannot be turned out of a foundry mechanically perfect in this respect. We have found many wheels in our tests of various makes that are double that amount and some that are even treble.

[A calculation follows, which we omit, of the loss from such slipping, etc. Car wheels slipping 9 ft. per mile increase the rolling friction by $\frac{9}{5280} \times 0.25$ (= coefficient of friction) × 2000 = 0.855 lbs. per ton. A very serious and, beyond doubt, common loss.—ED.]

The Austrian Zone System of Passenger Tariff.

The new Austrian passenger tariff resembles in many respects the zone tariff of the Hungarian railways, which was explained in ENGINEERING NEWS for May 3, 1890. Each station is a center for the zones about it and fares are calculated from each station at the rate of 0.6, 1.2 and 1.7 cts. per mile. The zones are formed by dividing the first 100 kilos. 62.138 miles) into five rings of 10 kilos. (6.214 miles) each, two rings of 15 kilos. (9.321 miles) each, and one of 20 kilos. (12.427 miles); all other zones are uniformly 20 kilos. (31.069 miles) wide. The price of a ticket to every place in the same zone is fixed by the distance of the outer limit of the zone from the starting point, so that it costs as much to travel 90 as it does 65 miles. This plan has less influence on the rates to the nearer stations than on those of more distant places, which latter do not receive the special reduction given on the Hungarian roads, which carry all persons traveling more than 155 miles without charge for the mileage covered above that limit. Owing to competition between the State and private lines and to the strong influence brought to bear by government employés on the directors of the railways, only 33% of the traveling public have been paying full fares under the old system, the reductions to workmen often amounting to 50% on local trains. All of these special rates are now forbidden and full fare is to be demanded in every case.

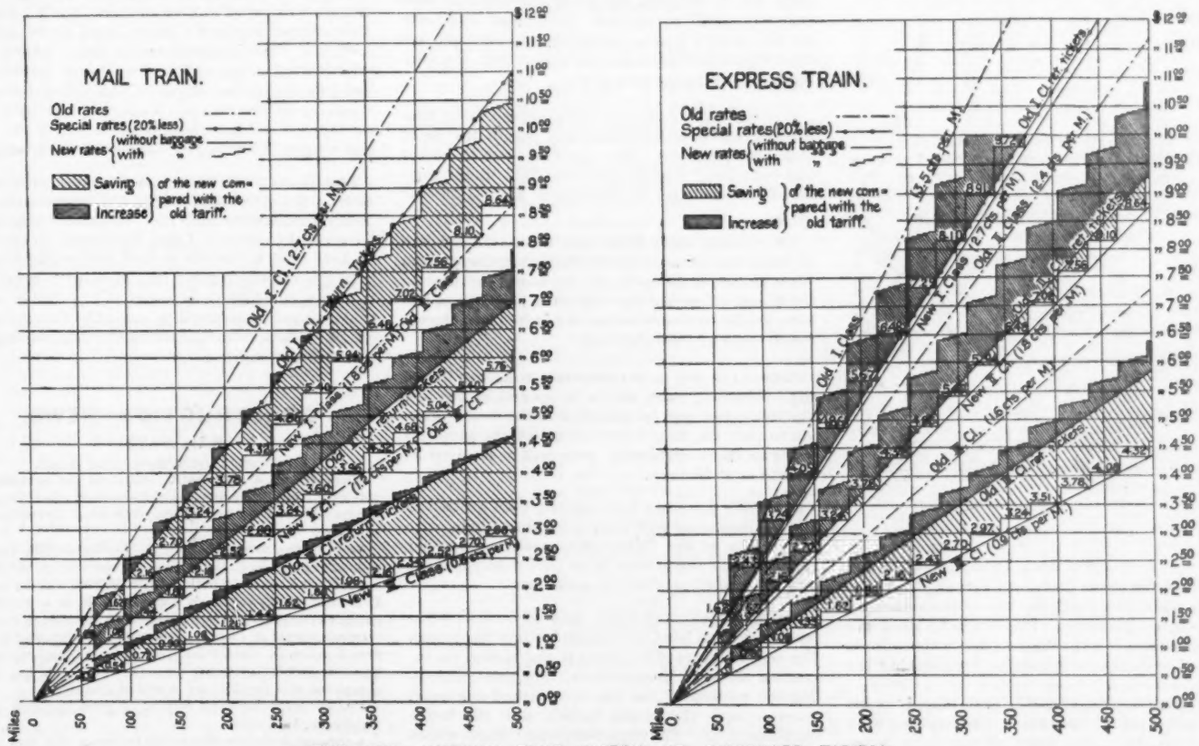
Formerly each person was allowed 25 kilos. (55 lbs.) free baggage. In the future, only hand baggage will go free, all other being taxed at the rate of 7.2 cents for every 22 lbs. carried 6,214 miles, the zones for baggage being drawn every 10 kilos. (6,214 miles), and hence do not coincide with those for passenger rates in the nearer stations.

The rates for express trains are 50% greater than those mentioned above, which are for the *post-zug*, or mail train.

The Austrian Minister of Commerce has decreed that the private lines must gradually adopt this zone tariff, so that in a few years the entire railway system will be in accord on the subject of rates.

From information taken from our Austrian and Swiss exchanges and from an address delivered by HERR BODE before the Austrian Engineers' and Architects' Union, we have prepared the accompanying diagrams showing the old and new rates. In preparing these, we have taken the gold value, 36 cts., of the florin as a basis of comparison, since its nominal value of 48 cts. is subject to as great fluctuations as Western grain rates.

The only explanation of the tables necessary concerns the broken line which represents the new rates with 66 lbs. of baggage. The stair-like outline is due to the fact that the baggage zones are 6.214 miles broad, and hence occurs 5 times as often as the passenger zones, when we have passed the first 100 kilos. (62.138 miles). This line is the best one to use in comparing the old and new plans, since the rates indicated by it are those with the same amount of baggage allowed by the old system. Another line to be carefully noticed is that showing the old return ticket rates, under which head we have combined a number of circular, commutation and other special rates which a large part of the public freely enjoyed.



THE NEW AUSTRIAN ZONE SYSTEM OF PASSENGER TARIFFS.

Showing the new and old, first, second and third class passenger fares, with and without baggage.

Taking the old first-class rates without reduction and the new rates with the same baggage allowance we find that the classes most benefited are the first and third classes of the mail train and the third class of the express train. Travelers on the second class mail trains receive no advantage from the new arrangement unless they travel wholly without baggage, if we compare these rates with the old commutation rates, which were used by a large proportion of travelers by this class. The first and second classes on the express trains are those which will be most burdened.

In examining this plan it will be seen that the injustice of making travelers without baggage pay for that which the others carry is done away with. On the other hand, a person going 70 miles has to pay a part of the fare of a man going 90.

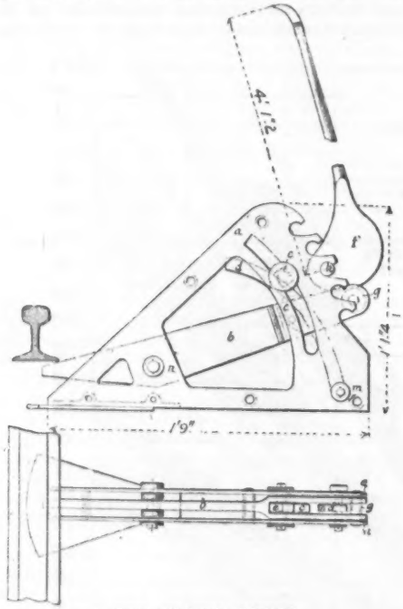
In our diagrams we have omitted, for the sake of clearness, the details of the first 100 kilos. (62.138 miles), but our readers can easily supply the omissions from the notes we have given. The experiment is a most interesting and significant one.

A Rail-lifting Device.

The illustration given herewith shows a French device for lifting the rail in track regulation, invented by Messrs. CITO and FUNCK, and illustrated in *Le Genie Civil*, of May 24.

The apparatus is made up of two detached parts, the lever proper, and the frame and secondary lever, as shown in the first figure. The main lever *b* is made of forged steel, and works on the axis *n* between two steel plates formed as shown, and separated by thimble bolts. The lever *b* is forked at the back end, with an arm *d* passing through it and revolving on the axis *m*. This arm *d* bears against a little oscillating shoe *c*, which also has its own axis riveted to the forks of the main lever. Another piece *e* slides by its own weight in curved slots cut in each cheek of the frame. When *e* bears against the arm *d* it keeps the latter in contact with the shoe *c*; it acts as a brake in any position of the lever. On the contrary, when the lever *b* tends to rise, the pin *e* will not lift, as it is bound, by the pressure from *d*, against the sides of the slots.

Between the ends of the fork of the lever *b* is a little steel roller *g*, working on a riveted pin. At



A RAIL-LIFTING DEVICE.

the back of the cheek plates are curved detents or teeth, in which the pin in the base of the secondary eccentric lever *f*, engages. Under the forward end of the apparatus is a fan-shaped plate which affords a base and prevents the apparatus from sinking too deeply into the soil.

In operation, a piece of oak is first placed under the rail at the point to be lifted. Then, raising with one hand the part *e*, the point of the lever is inserted between the rail base and the oak block, with the point of the lever as low as possible, and a slight push towards the track fixes the apparatus in place. The pin *h* on the handle is then engaged in one of the detents, and by drawing back the lever *f*, the back of the lever *b* is depressed and the load lifted. While this is being done the arm *d* turns on its axis *m* by its own weight, and *e*, slipping down, bears on the shoe *c*, and holds *b* in its position. This operation can be repeated over the five notches in the frame, if necessary.

The advantages claimed for this apparatus are, that it is simple and easy to operate; it only weighs 55 lbs., and the power exerted is in the proportion of 1 to 100. It is entirely clear of trains, and the rail can be let down on the ballast in 2 to 3 seconds of time when required. It is already in use on a number of French railways.

TRIPLE SCREWS FOR THE NEW CRUISER have been decided upon by Secretary TRACY on the recommendation of Engineer-in-Chief MELVILLE. The vessel is to be 400 ft. long, 58 ft. in beam, of 7,500 tons displacement and, it is hoped, will develop about 20,500 H. P. and make an average speed of 21 knots an hour, maintained for 4 hours, or 22 knots over a measured mile. If this is accomplished the cruiser will be the fastest ever produced. She is to have no armor, but is to be provided with a protective deck.

The three screws will be a most decided novelty in this country, nothing of the kind ever having been built here. But it is not to be an experiment, for the Italian government tried the system on the torpedo boat *Tripoli*, which developed a little over 19 knots. The *Duprey de Lorne*, now building, is to be fitted with triple screws, as a result of a series of experiments with the system on the *Carpe*, a French cruiser. Nothing has been decided as to the exact arrangement of the three screws, although it is expected that they will be placed in a triangle, with the apex below, the lower screw being considerably abaft the other two.

THE NEW RUSSIAN TORPEDO BOAT *Adler* is reported to have attained a speed of 26.55 knots on her trial trip. The boat is 150 ft. long, with 17 ft. beam, and has 150 tons displacement. She was built in Germany for the Russian Black Sea fleet.

THE RAFT built this year by Mr. Leary is making slow progress towards New York, and seems to have been even more shabbily constructed than its predecessors. A good part of the logs are reported to have already gone adrift. Vessel owners whose craft are in continual danger of collision with these dangerous drifting logs will have small sympathy for Mr. Leary's losses. Certainly international law should provide some means for preventing the scattering of such dangerous drift.

DOUBLE SHELL BOILERS are proposed by an English engineer to secure safety and permit the use of very high pressures. The space between the inner and outer shell is to be filled with fluid under pressure to relieve part of the strain on the internal shell.

THE GOVERNMENT WEATHER BUREAU has made an important advance by establishing stations in the West Indies, at Kingston, St. Thomas, Santiago de Cuba and other points. Hitherto the bureau has been unable to give warning of the frequent storms which come up from the Gulf.

PROPOSALS FOR A TELEPHONE EXCHANGE in the city of Havana, Cuba, are to be opened on Aug. 28. The concession will be awarded to the bidder offering to give the largest percentage of the gross receipts to the government. Bids will be received at Madrid or at Havana.

ELECTRIC WELDING has recently been utilized to join the lengths of wire used in making a 10-in. wire wound gun at the Watervliet arsenal. Another application of the process is for pipe welding in the manufacture of artificial ice machines.

AN ELECTRIC ELEVATOR, said to work satisfactorily, has been tried in this city by OTIS BROTHERS. The novel feature of the plant is the motor, the invention of Mr. R. EICKEMEYER. The rope controlling the motion of the car is attached to a lever, operates both the motor switch and the brake simultaneously. The motor stops and starts which gradually, and uses only sufficient power to manage the load. Although the field magnets are necessarily very powerful, they are so cased in that, it is said, a watch can be laid on the cover of the motor without injury.

NEWS FROM THE ALASKAN BOUNDARY SURVEY PARTY is to the effect that the boundary is located 28 miles further east than was formerly supposed. The change brings a valuable gold mining region into American territory.

THE CALIFORNIA ASPHALT DEPOSITS in Santa Cruz and Santa Clara counties furnish from 2,000 to 3,000 tons per year for shipment. The percentage of fixed bitumen in this asphalt, 24 to 25 %, is said to be greater than in any other known deposit.

A NOVEL PYROTECHNIC DISPLAY was witnessed in Colorado on July 4. Two barrels of kerosene and one of red fire were taken to the summit of Pike's Peak and burned, together with heavy rockets.

THE LONDON TOWER DESIGNS have been examined by the jurors appointed for the purpose. The first prize of 500 guineas has been awarded to Messrs. A. D. STEWART, J. M. MACLAREN and W. DUNN, of London, and the second prize of 250 guineas to Messrs. J. J. WEBSTER and T. W. HAIGH, of Liverpool. The design of Mr. MAX AM ENDE receives honorable mention. All three of these designs, and still more the 60 or 80 of others, were so far inferior to the Eiffel Tower in dignity and grace as to make it ridiculous to prefer them to a mere enlargement of the latter. This the committee in effect state, recommending no plan for construction.

PRESIDENT ANDREWS of the Steam Heating Co. is reported as saying that the order to shut off steam will be fought by the company. He declares that the steam users who turn the drip from their engines and in many cases their exhaust steam directly into the sewers are much more responsible for their heat than is the Steam Heating Co. The number of street openings made in 1889, he says, were 16,236 by gas companies, 1,827 by electric light companies, 851 by the Subway Construction Co., and but 457 by the Steam Heating Co. He neglected to say, however, that, considering the very limited territory covered by the steam mains, this is rather a bad record for his company after all, and that his openings were vastly more important and extended, on an average, than others, as we pointed out last week.

THE FIRST PNEUMATIC DYNAMITE GUN for Great Britain was tested at Cold Springs, N. Y., July 8. The contract required a 200-lb. shell to be thrown 3,500 yds. Four projectiles were fired, loaded with sand instead of dynamite. Two burst before they had gone far on their flight. Of the other two, one weighing 520 lbs. attained a range of 4,008 yds. and the other of the same weight reached 4,680 yds. The gun weighs 73,000 lbs.; the barrel is 50 ft. in length.

THE WORLD'S FAIR SITE AT CHICAGO is still undecided. Both the board of directors representing the local stockholders and the National Commission have voted to use the Lake front with so much of Jackson Park as may be needed, connecting the two by ample railway tracks; but in order to carry out this plan, to which there are not a few bitter opponents, an ordinance must be passed by the city council, and bills must be passed by the Illinois Legislature and by Congress.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Harrisburg & Potomac.—Work on the extension of this road from Bowmansdale to Harrisburg, Pa., is rapidly progressing and the line will be completed by the end of the year.

New York, Susquehanna & Western.—The Princeville & Winton R. R. Co. has been chartered in the interest of this company to build a railway from a point on the Delaware, Lackawanna & Western R. R. to a point between Carbondale and Scranton, Pa., a distance of 4 miles.

Coudersport & Port Allegheny.—The grading on the first 5 miles of the Coudersport & Port Allegheny R. R. between Coudersport and Sweden Valley, Pa., has been completed and tracklaying is now in progress.

Baltimore & Eastern Shore.—A press dispatch from Baltimore, Md., says:

A through line from Baltimore to Ocean City has been obtained by purchase and consolidation of the interests of the different railways into the hands of one set of men. The stockholders of the Baltimore & Eastern Shore R. R. Co. have purchased the Wicomico & Pocomoke R. R., which runs from Salisbury to Ocean City; the Bay Ridge R. R., running from Annapolis to Bay Ridge, and the property of the Chesapeake Terminal Co., which consists of the terminals in Anne Arundel Co. at Thomas Point, in Talbot Co. on the Bay Shore, and the transfer steamer *Thames River*. The Baltimore & Ohio sold the Bay Ridge R. R., which, with the roads on the Eastern Shore, makes a line from Annapolis to Ocean City in Worcester Co. 106 miles long, including the bay crossings. The entire property from Annapolis to Ocean City has been mortgaged for $1,600,000 for 30 years.

Findlay, Fort Wayne & Western.—A press dispatch from Findlay, Ohio, says:

The United States District Court to-day confirmed the sale of the American Midland, or rather the New York, Mahoning & Western Railroad, to parties representing the Findlay, Fort Wayne & Western Railroad, a corporation of which the Pittsburg, Akron & Western Company is the principal stockholder. The confirmation of this sale is sure to lead to the completion of the road to Fort Wayne, where it will have an important connection to Chicago. Just as soon as the material can be procured tracklaying will be begun west of Ottawa, where the grade is built for a number of miles. Inside of ninety days the cars will be running from Findlay to Fort Wayne, and before Christmas the road will be in operation eastward to Pittsburg.

Boston & Maine.—Civil Engineer, Geo. E. Gray, who is making the survey for the proposed line from East Wakefield, N. H., to a connection with the Maine Central R. R. at Cornish, Me., has completed the preliminary line as far as Limerick, Me.

Niagara Central.—At a meeting of the stockholders

recently held the capital stock of the company was increased to $1,600,000. It is announced that the line will be completed into the city of Toronto at an early date.

Verona Valley.—Work on the railway from Caldwell to North Newark, N. J., has been commenced and the line is to be completed this season. The road will cost $75,000. C. M. Harrison is President and N. O. Baldwin is Treasurer. It is thought that the New York, Lake Erie & Western R. R. will operate the road when completed.

New York, Ontario & Western.—The Ontario, Carbondale & Scranton R. R., running from Hancock, N. Y., to Scranton, Pa., a distance of 54.37 miles, has been completed and opened for traffic. The work was first undertaken by three companies; the Hancock & State Line and the Forest City & State Line railway companies, chartered in March, 1889, to build from Hancock, N. Y., to the Pennsylvania State line, 2.93 miles, and from Forest City, Pa., to a connection with the former, a distance of 27.92 miles; and the Scranton & Forest City R. R. Co., incorporated in December, 1889, to build a line from Scranton to Forest City, Pa., 23.52 miles. In April, 1889, the three companies were consolidated under the name of the Ontario, Carbondale & Scranton R. R. Co., and about the same time the N. Y., O. & W. R. R. Co., assumed control of the enterprise. The contract for constructing the division from Hancock to Forest City was let to Lathrop & Ellsworth and for the division from Forest City to Scranton to Dowling & Kennedy. The contract for the Bridge work was let to the Philadelphia Bridge Works. There are 54 iron bridges on the line, the most important of which are the bridge across the west branch of the Delaware River, 895 ft. long and 70 ft. high, and the Cadovia and Falls Creek viaducts, 510 ft. long and 70 ft. high, and 510 ft. long and 60 ft. high, respectively. The road connects the main line of the N. Y., O. & W. R. R. with the Wyoming coal fields, and passes through a rich section of the country,

Projects and Surveys.

South Fork.—Incorporated in Pennsylvania to build a line of railway from a point on the Pennsylvania R. R., near South Fork, via the South Fork of the Conemaugh River to the dividing line between Cambria and Bedford counties, a distance of 14 miles. Among the directors are: Geo. F. Huff, of Greensburg, Pa.; John Lloyd, Altoona, Pa.; Robert Pitcairn, of Pittsburg, Pa., and W. A. Patton, of Philadelphia.

Iron Range & Huron Bay.—Chartered in Michigan to build a railway from Huron Bay, Baraga County, Mich., to Champion, on the Duluth, South Shore & Atlantic R. R., in Marquette Co., a distance of 35 miles. The surveys have all been completed. The work will be generally light; maximum grade, 50 ft. per mile. The President and promoter of the company is James M. Turner, of Lansing, Mich., and Jas. F. Joy, C. H. Buhl and others of Detroit are interested. Milo Davis, of 55 West Fort St., Detroit, Mich., is Chief Engineer.

Bristol.—This company has been organized by J. J. Reilley, President; Geo. A. Ayer, Vice-President; W. H. Bosworth, Secretary, and S. J. Drake, E. B. Patterson, E. L. Cain, and J. M. Fitch, directors, to build a line of railway 7 miles long. Bids will be received for the grading and bridging until July 19. The company also wishes to purchase rails and equipment for the line and a large quantity of second-hand steel rails.

SOUTHERN.—Existing Roads.

Decatur, Chesapeake & New Orleans.—Officials of this road are reported as saying that the contracts for the entire line between Shelbyville, Tenn., and Decatur, Ala., have been let, and that work is now in progress to be completed by Oct. 1. The division from Shelbyville to Gallatin, Tenn., where connection will be made with the Chesapeake & Nashville R. R. has been surveyed via Lebanon and Murfreesboro, and another line will be surveyed via Murfreesboro and Nashville. It is stated that sufficient money to construct the road has been secured.

Albany, Florida & Northern.—The arrangements have been completed and all the contracts have been let for the construction of this Georgia railway. King & Hannan have the contract for the grading, A. R. Coulter & Co. have the contract for the bridge and trestle work and R. R. & R. N. Stewart will furnish the cross-ties. About 3,500 tons of steel rails have been ordered from the Pennsylvania Steel Co. and it is expected that these will be delivered in August and that tracklaying will begin early in September. The road is to be completed by Oct. 1. W. W. Campbell, of Albany, Ga., is Chief Engineer.

East Tennessee, Virginia & Georgia.—This company has leased the Louisville Southern R. R. and will operate it as a part of its system.

Charleston, Sumter & Northern.—A. Ames Howlett, of 115 Broadway, New York City, President of the Central Carolina Land & Improvement Co., writes as follows:

This company has under construction a line from Sumter, S. C., via Lamar, Darlington and Mandeville, to Bennettsville, S. C., a distance of 62.28 miles. Work is in progress from Sumter north, from Bennettsville south and from Darlington north and south. About 100 mules and scrapers and between 300 and 400 hands are now employed. The contract for the grading has been let to R. S. Pringle & Co., of Sumter, S. C. Williams & Turley have the contract for the bridging from Bennettsville to Robbins Neck, and Walton & Robinson have the contract for the division from Robbins Neck to Sumter. There will be a 243 ft. bridge with a 150 ft. draw-span over the Great Pee Dee River. The Phoenix Bridge Co. has the contract for building the structure. All of the right of way has been obtained and a large amount of local aid has been secured in cash and subscriptions to bonds. It is expected that tracklaying will begin about July 20, and that the road will be completed by Aug. 1. Maj. G. W. Earle, of Darlington, S. C., is the engineer in charge of construction.

Projects and Surveys.

Lexington & Eastern.—A press dispatch says:

The Lexington & Eastern R. R. Co. has been granted a charter. It is backed by English capital, represented in New York city by Messrs. J. H. Crosman and Arthur Macy. The company has under advisement the construction of a line through the coking, coal and timber fields of Pike, Knott, Knox, Perry, Letcher and Leslie Counties. Efforts were made to purchase the Kentucky Union R. R., and extend it from Jackson to Big Stone Gap, but that is the plan of the owners, and they will not sell. The line will therefore probably run from Beattyville along one of the three forks of the Kentucky River—probably along the South Fork to Harlan Court House—and thence almost due east to Big Stone Gap.

Cape Fear & Cincinnati.—We have received the prospectus of this company, from which we take the following:

The company was chartered in Sept., 1889, and proposes to build a railway from Wilmington, N. C., to Conway, S. C., with branches from Conway to Charleston, S. C., Albemarle, N. C., and Greenville, S. C., a total length of 485 miles. The route is through a good agricultural section of the country, and a large traffic in farm produce, fish and oysters, coal and timber is expected. At Southport, N. C., the road will make connections with steamship lines to New York and other Northern ports. The company proposes to issue $2,500,000 of bonds bearing 2% interest, the proceeds of which will be used in building and equipping the line. The officers of the company are: John W. Brown, Baltimore, Md., President; George B. Morton, of Baltimore, Vice-President and General Manager; J. H. Rowlinson, Secretary, and H. B. Bell, Treasurer.

Montgomery, Pensacola & Mobile.—Chartered in Alabama to build a railway from Lauerne to the Bay of Pensacola. Among the incorporators are: John C. Woolfolk, W. F. Joseph, F. C. Davidson and S. B. Stern.

NORTHWEST.—Existing Roads.

Duluth & Winnipeg.—Tracklaying is progressing on this road at the rate of 1 mile per day.

Duluth & Iron Range.—This company will, it is stated, build a branch from Tower along Stuntz and Armstrong bays to mineral lands.

Projects and Surveys.

Mt. Auburn & Taylorville.—John B. Matthews, of Taylorville, Ill., President, writes as follows:

This road is projected to run from Mt. Auburn, Ill., south to Taylorville, Ill., a distance of 16 miles. About four-fifths of the right of way has been secured and $8,000 of other local aid obtained. The road will be generally easy to construct, there being no large cuts or fills. The time for letting contracts is indefinite, but it is expected that the road will be completed by March 1, 1891. The company was chartered in April, 1890. John G. Dunnon is Chief Engineer.

Duluth Transfer.—O. H. Simonds, of Duluth, Minn., Secretary, writes as follows:

The surveys have just been commenced on this road which is projected to run along the shores of St. Louis Bay and St. Louis River, between Duluth and Fond du Lac, Wis. The length of the road, with its various spurs to the wharves and mills, will be 25 miles. The road will do a general freight transfer business with the railways entering Duluth. About one mile of the line has already been completed, and more will be finished this season. The company was chartered May 31, 1890. A. Harrington is President and W. B. Patton is Chief Engineer.

Huron & Sioux Falls Short Line.—Active steps are being taken by the people along the route to secure the construction of this road, and it is probable that surveys will soon commence. The road is projected to run from Sioux Falls, So. Dak., to Wolsey; So. Dak., a distance of 110 miles. O. W. Bair, of Huron, is President.

North Wisconsin & Lake Superior.—Incorporated in Wisconsin to build a railway from Oshkosh, Wis., to Keweenaw Bay, Barago County, Mich., a distance of 200 miles. Among the incorporators are: Geo. Beyer, O. A. Ellis, W. P. Cook, E. G. Murden, and F. F. Wheeler.

Menominee River, Aconto & Southern.—Chartered in Wisconsin to build a railway from Marinette to Seymour, Wis. The incorporators are the same as those of the North Wisconsin & Lake Superior R. R. Co.

Chicago & St. Louis.—Incorporated in Illinois to build a line of railway from Chicago to East St. Louis, Ill. Among the incorporators are: A. S. Hinkley, Hinsdale, Ill., and Benj. F. Cummings, of Chicago.

Kickapoo Valley & Northern.—Work is reported on this road projected to run from Wanseka to Wilton, Wis., 8 miles. E. I. Kidd, of Prairie du Chien, Wis., is President.

SOUTHWEST.—Existing Roads.

Kansas City, Watkins & Gulf.—About 10 miles of track have been laid on this road from Lake Charles.

New Orleans & Northwestern.—It is stated that the line from Rayville to Vidalia, La., 72 miles, will be completed by Aug. 1.

Leavenworth & St. Joseph.—Work is being pushed preparatory to the early commencement of construction from St. Joseph to Beverly Junction, Mo. It is expected that work will begin in about 1 month.

Projects and Surveys.

Camden & Alexandria.—C. C. Henderson, of Camden, Ark., President, writes as follows:

Contracts for the construction of this road will be let about July 15, and it is expected to have a portion of the line completed and in operation by Jan. 1, 1891. The road is projected to run from Camden, Ark., to Alexandria, La., a distance of 175 miles, and the line has been located from Camden to Eldorado. The greater part of the right of way has been secured, and about $25,000 in cash and 15,000 acres of timber land have been obtained in aid of the enterprise. The principal business of the road will be in cotton, timber and general merchandise. W. R. Smith, of Camden, is Chief Engineer.

Memphis, Little Rock & Indian Territory.—This company has filed a mortgage with the Holland Trust Co. for $1,200,000, the proceeds to be used in building the road The company was organized to build a railway from Little Rock, Ark., to the Indian Territory line, about 150 es.mil G.A. I. Milair is President.

ROCKY MT. AND PACIFIC.—Existing Roads.

Seattle, Lake Shore & Eastern.—Chief Engineer Talcott is reported as saying:

The span on the Stillaguamish River bridge has been swung into place, and men are at work putting the superstructure on the trestle north of the bridge. The only thing that is delaying operations now is the trestle work north of the bridge, a distance of 3,800 ft. There is another trestle 65 ft. high, half a mile from the north end of the Stillaguamish. When these are completed the road will be finished to the Pilchuck River, which will carry the line 65 miles from Seattle. There will then be a bridge and a quarter of a mile of trestle across the Pilchuck, which it will take about two weeks to fill. By that time the grading will be done to McMurray Lake and the track will be laid there at once. It will take about 60 days to get across the Skagit River, and in the meantime the line will be pretty well railed to McMurray Lake. At the Skagit River bridge the piles have been nearly all driven from the north bank to firm land, a distance of about 5,000 ft., and the track is laid on the beach about 2¼ miles north. The connection track has been made with the Fairhaven & Southern, and another connection track to the Seattle & Northern Ry. There are also 20 miles of the line graded and ready for the rails from the boundary line to the south fork of the Nooksack River.

Pecos River.—About 5 miles of track have been laid and 10 miles of grading finished on this New Mexico road.

Port Townsend Southern.—Tracklaying on the first 20-mile section of this road has been completed.

Great Northern.—The contract for constructing the first 72 miles of the Seattle & Montana R. R., from Seattle to the Skagit River, will be awarded at once.

Projects and Surveys.

Drain & Coos Bay.—The surveys for this Oregon railway will be commenced at once.

Salt Lake & Bountiful.—Civil Engineer H. S. Joseph, of Salt Lake City, Utah., has completed the surveys for this road, which is projected to run from Salt Lake to Bountiful, Utah, a distance of 8 miles. Grading will begin as soon as the right of way can be secured.

FOREIGN.

Mexico.—The *Mexican Financier* reports the following railway concessions and modifications of concessions granted by the Mexican Government:

The concession granted to Mr. Pedro Diez Gutierrez for a railway from El Potrero to El Cedral, Catorce, Matehuala and Rioverde has been modified by extending the time for the completion of all the lines included in the concession for five years from the 11th of June, 1892.

A concession has been granted to Mr. Gonzalo A. Esteva for a line of standard-gauge railway between the cities of Guadalajara and Aguascalientes. The concession is for 99 years, and carries with it the right to import, free of duty, construction and operating material during 15 years and a subvention of $8,000 per kilo., payable in six per cent. bonds. Surveys must begin immediately and construction within ten months.

By the terms of the modification of the original concession for the Mérida, Izamal & Sotuta R. R., the line may be built from Mérida by way of Tekantó to Izamal, the company being relieved from the obligation of building a line from Tixkokob to Sotuta.

The concession of the Vera Cruz, Anton Lizardo & Alvarado Ry. and of that for a railway from Rio San Juan to the National Tehuantepec Ry. have been modified. The Rio San Juan line will start from a point in front of the port of Alvarado or from some point where the river or one of its affluents shall be navigable for vessels drawing a metre or more of water, and terminate at some point on the Tehuantepec Ry. proposed by the company and approved by the Department of Public Works. The time for building the line is also extended. The two companies may establish docks, ferries, build bridges, piers, etc., in facilitation of their business. The Vera Cruz & Alvarado Ry. Co. may also build a standard-gauge line from Medellin to Alvarado, but without subsidy.

A concession has been granted to Mr. Gonzalo A. Esteva, for a standard gauge railway from Guadalajara to the port of Chamela on the Pacific Ocean. The railway is to have its accompanying telegraph line. Surveys must begin immediately, and construction within 10 months from the date of this contract, the plans being first approved. The railway and telegraph must be completed within 10 years, under penalty of confiscation. The usual exemption of duties on construction and operating material, during 15 years, is granted. In order still further to aid the construction of the railway and telegraph, the Government guarantees the concessionaire a net annual profit of 7%. This guarantee will exist for 35 years.

The concession granted to General Felipe B. Berriozábal and Mr. Sebastian Camacho, for building a line from Tula, on the Mexican Central Ry., to Zacualtipan, passing through the city of Pachuca, with power to extend the line to Tampico, or Túxpan, has been modified. The new articles authorize the building of a standard-gauge line from Tula or other convenient point on the line of the Central to the city Pachuca, with power to extend the line to Zacualtipan and Tampico, or Túxpan, with the assent of the Department of Public Works. Notice of a purpose to make use of the right to extend the line, as specified, must be given within two years or no subsidy will be paid on the extension.

A concession has been granted to Joaquin Casasus, Esq., representing Messrs. Llovera & Co., for building a pier in the port of Campeche and a railway connected therewith.

CITY TRANSIT.

Elevated Railway.—*Montreal, P. Q.*, is considering the building of a line on several streets.

Gravity Railway.—*Philadelphia, Pa.*: A syndicate has been formed with Wm. Wharton, Jr., as president, to build a five-mile line in the western part of Fairmount Park. It will start from a point 245 ft. above the Schuylkill River, and run nearly 15,000 ft. by gravity. Then the cars will be hauled the remaining distance by electric motors.

Dummy Railways.—*Proposed* at Bristol, Conn., and Meridian, Miss.

Los Angeles, Cal.—Some of the street lines contemplate changing from horse to motor cars.

Tacoma, Wash.—The Tacoma & Puyallup Ry. intends to extend its lines.

Horse Railways.—*Lawrence, Mass.*: The Merrimac Valley Ry. will extend its lines to Haverhill and Andover. The capital stock of the company has been increased to $300,000.

Brooklyn, N. Y.—The Atlantic Ave. Co. has petitioned for consent to extend its lines.

Asbury Park.—A company has been formed to build a line from this place to Belmar, a distance of 2 miles.

Provo, Utah.—About 5.5 miles are now building and 6 miles more are proposed.

Electric Railways.—*New Companies.* Metropolitan Electric Ry. Co. of Chicago, Ill.; incorporators, L. Fox, M. Brand, H. Vollman; capital, $5,000,000. Houston & Covington Electric Ry. Co. of Houston, Tex.; incorporators, J. P. Inwin, O. W. Crawford, J. F. Rowley, capital $10,000.

Proposed, at Baltimore, Md.; Manchester, Va.; Florence, Sheffield and Tuscumbia, Ala.; Knightstown, Ind.; Cairo, Ill.; Grand Forks, Minn.; Cedar Rapids, Ia.; Austin, Tex.; Salt Lake City, Utah; Aberdeen and Centralia, Wash.

Extensions will be made on the West End Ry. of Boston, Mass.; at Amsterdam, N. Y.; Pittsburg, Pa., and Great Falls, Mont,

Attleboro, Mass.—A line will be built to Dodgeville, Hebronville and Lebanon. Later it is intended to extend the system to Pawtucket, R. I.

Beverly, Mass.—The cost of operating the storage battery cars has been found to be 6·5 cts. per mile.

Troy, N. Y.—The street lines here will adopt electricity as a motive power. A line running to Waterford, Cohoes, Green Island, West Troy, Albany, Port Schuyler and Lansingburgh is under discussion.

Buffalo, N. Y.—A railway will be built to Niagara Falls, a distance of 20 miles. The street railway company intends to pay out $5,000,000 in developing the system.

East Reading, Pa.—The existing line will be extended to Boyertown, a distance of 18 miles.

Dallas, Tex.—The Rapid Transit Co. will construct a line 5 miles long.

Pueblo City, Colo.—The Railway Co. has bonded its property for $500,000 in order to buy an electric equipment.

North Yakima, Wash.—A street railway and power company has been incorporated by W. Ferguson and others to build 3 miles of railway here.

BRIDGES, TUNNELS AND CANALS.

Tariffville, Conn.—The bridge across the Farmington River at this place has been declared unsafe. It will probably be replaced.

Marietta, Ga.—Bids will be received until July 28 for the construction of a bridge across Soaps Creek. Address J. W. Stone, Marietta, Ga.

St. Paul, Minn.—A bridge will be built over the trucks of the Great Northern Ry. at Lexington Ave.

New Iberia, La.—The old wooden bridge across the Teche River will be replaced by an iron structure.

Llano, Tex.—The city will build a bridge over the Llano River.

Missouri River Bridge Co.—The Bear Lake and River Water-works & Irrigation Co. has closed a contract with this company for two iron viaducts over the Malad River. One has a water way of 7 ft. × 20 ft. with a dead load of 11,000 lbs. per lin. ft., and is 378 ft. long and 85 ft. high. The other has an iron flume 5 ft. × 12 ft., and is 130 ft. long, with wood approaches.

Warnerville, N. Y.—A petition is being circulated to call a special town meeting to decide as to the advisability of building an iron bridge at this place.

Wabasha, Minn.—The Pontoon bridge of the Milwaukee & St. Paul road near Wabasha is to be replaced with a new one on a site farther down than that now occupied. Surveys are now being made.

Wheeling, W. Va.—Bids will soon be asked for constructing the stone arch bridge over Wheeling Creek at Main St.

WATER-WORKS.

NEW ENGLAND.

Ellsworth, Me.—The new works will be constructed by S. Knapp.

Milton, Mass.—Sealed proposals for laying about 10 miles of cast-iron pipe will be received by the Milton Water Co. until July 12. Percy M. Blake, of Hyde Park, is the Engineer.

Somerville, Mass.—A considerable amount of extensions will be made.

Beverly, Mass.—Meters are to be put into use.

Springfield, Mass.—The Common Council has voted favorably on the question of issuing $125,000 of water improvement bonds.

Boston, Mass.—The Committee on Water has applied to the Mayor for $100,000 or $150,000 for the extension of mains

Lowell, Mass.—Messrs. Ladd, Coburn and Gallagher have been appointed a committee to purchase a new pumping engine.

MIDDLE.

Saratoga Springs N. Y.—The Water Commissioners have adopted a resolution requiring the owners of all mineral springs in the village using water for any purpose to connect all pipes running into their premises with a water meter on or before August 1.

Glen Falls, N. Y.—The Ludlow Valve Mfg. Co., of Troy, N. Y., has been awarded the contract for furnishing the hydrants. The contract for furnishing valves, 44 extension boxes, etc., was awarded to Mr. Keating, of New York City.

Gouverneur, N. Y.—We have received the following information from the City Clerk:

A resolution was adopted on June 29 authorizing the city to issue $60,000 of bonds for providing the village with a pure and wholesome water supply, to be issued in denominations of $1,000 each and to bear a rate of interest not exceeding 3½%. The matter is in charge of a Board of Water Commissioners

Mohawk, N. Y.—Bids for the supplies needed for building the new works will be received until July 16. For information regarding quantities, etc., address the Board of Water Commissioners.

Cohoes, N. Y.—The $25,000 of improvement bonds have been sold to the Cohoes Mechanics' Saving Bank.

Watkins, N. Y.—Sealed proposals will be received by the Board of Water and Sewer Commissioners until July 23 for the material and labor required to construct works. Blank forms will be furnished upon application. The members of the Board are: Daniel Beach, Oliver P. Hurd, Frederick Davis, Jr., William H. Wait and William N. Love.

Brooklyn, N. Y.—A resolution has been passed authorizing the issue of $196,000 of bonds for new mains, etc. Another one was passed authorizing the expenditure of $65,000 for erecting a stand-pipe at Prospect Park. Steps are being taken by the city to purchase the rights and privileges of the Long Island Water Supply Co., and a commission of three members will probably be appointed to negotiate with the company. The estimated value of plant is reported to be $1,000,000.

Brockport, N. Y.—Pipe-laying is progressing rapidly.

Ellicottville, N. Y.—The Ellicottville Water Co. has purchased several springs near the village for the water supply system.

Rochester, N. Y.—The Executive Board has adopted resolutions providing a new pumping plant of 2,000,000 galls. daily capacity.

Trenton, N. J.—Improvement bonds for $1,000,000 are to be issued.

Lancaster, Pa.—A new 20-in. main will probably be laid.

Allegheny, Pa.—Bonds for $100,000, bearing 4% interest, have been sold.

Fleetwood, Pa.—We have received the following information from J. K. Merkel:

The estimated cost of the new works is $20,000. The proposed source of supply is a spring, 1¼ miles distant. A reservoir would be constructed. D. F. Keichner, Secretary of the Common Council, can furnish information.

Chambersburg, Pa.—About $35,000 are to be expended for improvements.

Perth Amboy, N. J.—The City Council has passed a resolution to inform the company that it is now proposed to purchase their plant. It is reported that the company will sell its plant for about $85,000. The Taxpayers' Association, which has the matter in charge, now has an engineer at work investigating the cost of supplying the city with water from Mill Brook, 5 miles west of the city.

SOUTHERN.

Crewe, Va.—Works will probably be put in by the Crewe Land & Improvemen Co. Secretary, M. W. Ryan, Roanoke, Va. Capital stock, $150,000.

Hicksville, N C.—Bids will be received until July 13 for building works.

Morgantown, N. C.—Works are projected.

Spartanburg, S. C.—The company has contracted to supply the Spartan Mills with water. It is reported that about 2,000,000 galls. daily will be required.

Florence, S. C.—A 10-in. artesian well will be sunk to a depth of 1,500 ft. by C. L. Parker, of St. Augustine, Fla.

Kensington, Ga.—The Kensington Water-Works Co. has been incorporated by F. R. Pemberton, J. F. Harris and others, of Chattanooga, Tenn., to build works.

Little Rock, Ala.—It is proposed to issue $200,000 of bonds for constructing works.

Greensboro, Ala.—A committee has been authorized to contract for boring a well.

Uniontown, Ala.—A stand-pipe, 15 ft. in diameter by 80 ft. high, together with pumping machinery, is to be erected.

Okolona, Miss.—Bids for sinking an artesian well will be received by James Williams until July 15.

Plaquemine, La.—The leading citizens are interested in the construction of works and negotiations are now in progress.

New Orleans, La.—The Council has contracted for sinking a well at $1,500.

Middlesborough, Ky.—A. H. Martine, of Knoxville, Tenn., will have charge of the construction of the new works for the Middlesborough Water Co.

Louisville, Ky.—Plans for the new stand-pipe have been submitted to the City Council and work will probably be commenced soon. Chief Engineer Hermany is preparing estimates for the proposed improvements to the mains, to include laying a 48-in. pipe from Crescent Hill reservoir through the city.

NORTH CENTRAL.

Xenia, O.—Steps are being taken by the Board of Managers of the Ohio Soldiers' and Sailors' Orphans' Home to provide the institution with a system of water supply. Two plans are now projected; one to contract with the Xenia Water Co., and the other to establish an independent system, taking the supply from springs, ½ mile distant.

Steubenville, O.—It is probable that new pumping machinery will be purchased this season.

Zanesville, O.—The following improvements will be made:

Erect a new stand-pipe, lay about 5,000 ft. of 30-in. and 2 miles 12-in. pipe. Bonds for $50,000 will be issued for these improvements.

Mount Vernon, Ind.—Bonds for $25,000, bearing 6% interest, are being offered for sale by H. M. Payson & Co., of Portland, Me.

Michigan City, Ind.—Works are projected.

West Indianapolis, Ind.—It is probable that the town will be supplied with water by the Indianapolis Water Co. About 50 hydrants would be set by the company.

St. Johns, Mich.—The vote on the question of further bonding the village for $1,500 for extending and improving the works was carried by a majority of 113.

Peru, Ill.—The Peru Artesian Water Supply Co. has been formed by W. G. Reeve and others to furnish a pure water supply.

Winnetka, Ill.—Works all projected.

Tomahawk, Wis.—An engineer is making surveys for the Tomahawk Electric Light & Water Co. for a water main from Clear Lake to the town, a distance of about 4 miles. The lake is about 70 ft. higher than the town.

La Crosse, Wis.—Calls have been made for a better water supply system. The supply is inadequate for fire protection, and considerable trouble is experienced from muddy water.

Lake Geneva, Wis.—James E. Heg has sent us the following:

Hinchcliff & Co., of Chicago, contractors for buildings, and C. E. Gray, Jr., & Co., of White Water, Wis., contractors for pipe-laying for the Lake Geneva Water and Light Co., have nearly completed their work. Water is pumped from wells to a tank of 100,000 galls. capacity. There are four miles of mains, and the city will pay $2,500 per year for 50 hydrants for 25 years. The population is 2,600.

Milwaukee, Wis.—The following bids have been received for constructing a tunnel, 7½ ft. in diameter by 3,000 ft. long, under Lake Michigan:

Bidders.	Furnishing and putting crib in place, complete.	Shore tunnel per lin. ft., including distributing wells with connections and the gate covers, 200 lin. ft.	Shore shaft complete per lin. ft., with coping and cover and all connections complete, 153½ lin. ft.	Lake shaft complete per lin. ft., including iron cylinders with all connections, 140 lin. ft.	Lake tunnel per lin ft. and extensions on opposite sides of each shaft, 3,157 lin. ft.	Rock excavations per cu. yd., 120 cu. yds.	Section No. 1 of the intake complete (not including crib), in the aggregate.
C. H. Starke	$38,000	.....	.....	.....	.....	.....	.....
John J. Crilley	.....	$20.00	$400 00	$433	$20.00	$7	$191,200
John O'Neil	34,000	28.00	80.00	172	28.00	7	132,876
Thomas R. Bentley and Wenzel Strachota	.....	42.50	85.50	170	29.40	10	141,989
Wm. Forrestal	34.500	30.00	100.00	125	27.50	10	128,667
Shailer & Schniglau	40,000	30.00	55.00	145	26.50	12	121,643

The contract for the crib was awarded to John O'Neil; for the rest of the work to Shailer & Schniglau.

NORTHWESTERN.

Hampton, Ia.—A vote was to have been taken on July 7 on the question of putting in works.

Sioux City, Ia.—A supply well 8 ft. in diameter by 45 ft. deep is to be developed. It has been proposed to purchase a pumping engine to raise water from the Missouri River for temporary relief.

West Duluth, Minn.—The construction of the new works has been commenced. Five lines of main will be laid at once, and additional mains in the future as they may be needed.

Minneapolis, Minn.—About 45,000 ft. of new mains, 16 to 6 ins. in diameter, have been laid this season.

Horton, Kan.—The question of putting in works is being discussed.

Leavenworth, Kan.—The water supply has recently been investigated by Dr. Carpenter and reported to be impure.

Phillipsburg, Kan.—The town has voted to put in works.

Omaha, Neb.—The water company will place some new fountains.—The following has been submitted to the City Council:

The Economical Water-Works Co. has offered to give the pledge of the Robert Sewell, of New York, that the new company, if chartered, will not sell out its franchise to the American Water-Works Co., nor take any step prejudicial to the interests of the city. It will give a bond, to be approved by your board, in the sum of $100,000, that it will furnish citizens with pure filtered Missouri River water at 25% less rates than the American Water-Works Co. now taxes the people. It proposes to begin work within 30 days after the charter shall have been granted and the bond approved, and to push the work of the company with such rapidity as will meet reasonable exactions. What we desire is the right to provide pure water to the city in competition to the American Water Co.

Lincoln, Neb.—The general improvements to the water supply system, which have been proposed for several years, will probably be made this season.

Fargo, N. Dak.—The time for receiving bids for building the new works has been extended two weeks to enable parties which have applied for specifications to receive them and submit propositions.

SOUTHWESTERN.

Mound City, Mo.—Works costing $14,000 are to be constructed. Bonds for that amount will be issued.

Sulphur Springs, Tex.—The City Council awarded the contract on July 3 for a system of water-works and sewerage. The contract runs for 30 years. There are to be 3 miles of mains, 35 hydrants, and 3 miles of sewerage, for which the city will pay an annual rental of $3,250. Work will be commenced at once.

Ennis, Tex.—Thomas & Gorman, of Houston, have received the contract to erect an electric light plant and construct works.

Wichita Falls, Tex.—The Wichita Falls Water Improvement Co. has been incorporated with a capital stock of $125,000.

Santa Fé, N. M.—The question of building two new reservoirs is being discussed by the company.

Wallace, N. M.—A well is to be dug in the La Bajada cañon at an estimated expense of $1,000. Superintendent Dyer has charge of the matter. The water system in the La Bajada cañon, at the foot of Malapai Hill, about 8 miles from Wallace, cost the company $78,000. A $5,000 tank has been finished at Wallace, and division headquarters are to remain there.

PACIFIC.

Kalama, Wash.—All the stock has been subscribed for and the building of works will soon be begun.

Olympia, Wash.—The Olympia Water-Works Co. has been incorporated with a capital stock of $150,000.

Seattle, Wash.—Consulting Engineer Benezette Williams, of Chicago, Ill., has submitted his report to the City Council for the distribution system. It has been adopted, and the City Clerk directed to advertise for bids for furnishing the quantities specified, which are as follows: The engineer's estimate of the cost is also given:

CAST IRON PIPE.

8,000 lin. ft. 30-in. pipe at $7.75; 5,000 lin. ft. 24-in. at $5.85; 13,800 lin. ft. 20-in. at $4.50; 2,700 lin. ft. 16-in. at $3.30; 5,900 lin. ft. 12-in. at $2.15; 9,700 lin. ft. 10-in. at $1.70; 24,000 lin. ft. 8-in. at $1.30; 60,000 lin. ft. 6-in. at $1.00.

WROUGHT IRON PIPE.

12,000 lin. ft. 12-in. pipe at $2.00; 6,000 lin. ft. 8-in. at $1.10; 4,000 lin. ft. 6-in at 80c.; 300 fire hydrants at $15; valves and valve boxes, $3,500. Total, $339,645.

About 170 tons of special castings will also be required.

Cheney, Wash.—A syndicate composed of James Steel and others, of Portland, Ore., has recently secured control of the works at this place, and a complete plant is to be established.

East Portland, Ore.—The difficulty over the water supply has been settled by the city passing an ordinance amending the franchise of the East Side Water Co., and granting new privileges. The company has been reorganized, and Isaiah Buchman elected President, and J. A. Newell, Secretary. Ground for the site for the pumping station has been purchased. The new supply will be taken from wells. Two compound condensing pumping engines of 3,000,000 and 2,000,000 galls., respectively, will be purchased at once. A considerable amount of 10-in. and other sizes of pipe, hydrants, and valves, are also to be ordered. A stand-pipe is to be erected. The capital stock of the company is $120,000, of which $68,000 has already been taken.

San Bernardino, Cal.—The Devil Cañon Water Co. has been incorporated with a capital stock of $100,000. The directors are: W. R. Wiggin, C. L. Cate, C. H. Rhodes, Smith Haile and J. J. Deming.

Petaluma, Cal.—The Petaluma Water Co. has let a contract to build a 50,000,000-gall. reservoir on Sonoma Mountain, on the Lower Ranch, about 5 miles from Petaluma.

Los Angeles, Cal.—A resolution offered by Mr. Shafer instructing the City Surveyor to prepare plans and estimates for a complete system of works for domestic supply, under municipal ownership, has been adopted by the City Council.

Provo City, Utah.—The proposition recently submitted by Witcher Jones, of Salt Lake City, has been accepted and a contract signed by the city. The proposition was from the Provo City Water-Works Co., having a capital stock of $25,000. President, S. R. Thurman; Vice-president, O. W. Powers; Secretary, D. W. Straub; Treasurer, Benjamin Bachmann. Work is to be commenced at once. The franchise runs for 50 years. The estimated cost of the plant is $300,000.

Boise City, Idaho.—The Boise Water-Works Co. has been incorporated by Hosea B. Eastman, Geo. L. Shoup, Wm. H. Ridenbaugh, Christopher W. Moore, Timothy Reagan, Peter Sonna, Alfred Eoff, Geo. Ainslie and Richard Z. Johnson. Capital stock, $200,000; $135,000 has been subscribed.

CANADA.

Cote St. Antoine, P. Q.—A by-law is to be voted upon on July 15 providing for the issue of $100,000 of bonds for the purchase of the plant, rights and privileges of the Cote St. Antoine Water Co.

Owen Sound, Ont.—Tenders will be received on July 14 for 550 tons of 10, 8 and 6-in. cast-iron pipe, by Jas. O. Kennedy, Town Engineer, or Jno. Armstrong, Chairman Water-Works Committee.

West Toronto Junction, Ont.—Sealed proposals were received on July 10 for $50,000 of 30-year 5% bonds, interest payable semi-annually; and $25,000 of 30-year 5% bonds, interest payable annually.

London, Ont.—Improvement bonds for $70,000 are to be issued.

Toronto, Ont.—The question of adopting meters to prevent the waste of water is being considered.

ARTESIAN WELLS.

Aiken, S. C.—A well is to be put down by the city. Address the Mayor.

Belleville, Ill.—The Belleville Steel Works is to sink a well.

Galesburg, Ill.—Specifications for the new works have been adopted. The wells will be located in the valley of Cedar Park.

IRRIGATION.

Albuquerque, N. M.—The Bernalillo Co. Water & Improvement Co. has been incorporated by M. S. Otero, W. B. Slaughter, Lorion Miller, W. B. Childers, of Albuquerque, and Robert L. Ball, of Mitchell Co., Tex. Capital stock, $200,000. The object of the corporation is to construct lines of ditches and pipes for the purpose of conveying water from the Rio Grande River, and supplying it for domestic and industrial purposes to the people of Albuquerque and vicinity. The Rio Grande Irrigation and Colonization Co. will soon begin work. A dam will be built in the Cañon of Santa Ana, forming a reservoir 8 miles long by 3 miles wide. The company will construct 200 miles of canals, not including laterals. They will be fed by a system of reservoirs. This is one of the largest schemes ever undertaken in the Southwest, and it is expected will bring $5,000,000 into the Territory in the next two years.

Weed, N. M.—The Agua Chiquito Reservoir & Irrigation Co. has been incorporated by John E. Prather, Virgil H. Lusk, Thos. J. Watts, Samuel U. Prather and James C. Cady. Capital stock, $100,000.

Yakima, Wash.—The bill granting the Northern Pacific R. R. and Yakima Irrigation Co. the right of way through the Yakima Indian Reservation has been acted upon favorably.

Fresno, Cal.—The 76 Land and Water Co. has sold its canal and water rights to the irrigation district recently formed for the purpose of taking in all the land capable of being watered by this canal system. The purchase price is $410,000. The district is mostly in the southeastern portion of Fresno Co.

SEWERAGE AND MUNICIPAL.

Sewers.—*Assessments* have been made at Buffalo, Brooklyn and New York, N. Y.; Newark, N. J., and Pittsburg, Pa.

Ordered at Buffalo and Poughkeepsie, N. Y.; Newark, N. J.; Toronto, Ont.; St. Louis, Mo.; Milwaukee, Wis.; Albuquerque, N. M.

Saco, Me., has appropriated $10,000 for sewerage purposes; Quincy, Mass., $400,000; Gouverneur, N. Y., $35,000; Decatur, Ill., $125,000.

Troy, N. Y., is discussing the laying of a 20 by 40-in. line, and Poughkeepsie, N. Y., has decided to build 700 ft. of pipe sewer.

Knoxville, Tenn., is making surveys for a complete system.

Chicago, Ill., has voted $25,000 for engineering purposes to be used in increasing the capacity of the outfall sewer.

Paving.—*Assessments* have been made in New York, Buffalo and Brooklyn, N. Y.; Allegheny, Pa.; Omaha, Neb.; Ogden and Salt Lake City, Utah.

Ordered at Portsmouth, N. H.; Boston, Mass.; Providence, R. I.; Buffalo, N. Y., asphalt; Brooklyn, N. Y., granite; Baltimore, Md.; Cincinnati and Columbus, O., Clinton, Ia., 35,000 sq. yds., probably brick; Cedar Rapids, Ia., 7 miles.

Washington, Pa., has decided to issue bonds for street and sewer work. Plans and specifications are being prepared by Wilson & Smith.

Bonds.—Rochester, N. Y., will issue $25,000 of park bonds; Cincinnati, O., $100,000 of city hall bonds; Cote St. Antoine, P. Q., $350,000 of sewer bonds; Nashville, Tenn., $75,000 of sewerage bonds, and Tacoma, Wash., $200,000 of city hall bonds.

Gas.—The Western Gas Construction Co. has been incorporated at Fort Wayne, Ind., by G. V. Lloyd, O. N. Guldlin, F. A. Shumacher, with a capital stock of $50,000.

The Monongahela Natural Gas Co. will build a five-mile line directly south from Monongahela City, Pa.

ELECTRICAL.

Electric Light.—*Proposed*, at Laconia and Lebanon, N. H.; Randolph and Palmer, Mass.; Jamestown, R. I.; Herkimer and Medina, N. Y.; Laurel, Md.; Norfolk and Pulaski City, Va.; Morgantown and Wilson, N. C.; Greenville and Rock Hill, S. C.; Tarpon Springs, Fla.; Anniston and Selma, Fla.; Lawrenceburg, Salisbury and Kimball, Tenn.; Henderson, Louisville and Paducah, Ky.; Monroe, O.; Bushnell, Cairo and Ottawa, Ill.; Dexter, Rockford and Tecumseh, Mich.; Centreville and Keokuk, Ia.; Brenham, Henrietta, Navasota and Sherman, Tex.; Philipsburg, Mont.; Alameda, Cal.

Voted, at Binghamton, N. Y.; Macon, Ga., where $25,000 has been voted for the purpose; Talladega, Ala.; Batesville, Ark.; Hiawatha, Kan.; Falls City, Neb.; Centralia, Wash.

Extensions of existing plants are probable at Holyoke and Beverly, Mass.; Newport, R. I.; Newark, N. J.; Charlotte, N. C., where a new engine and a 30 arc light dynamo are certain; Union, S. C.; Decatur and Fort Payne, Ala.; San Antonio, Tex.; Marysville, Kan.; Tacoma, Wash.

Orange, Mass.—A 150 H. P. engine and a 650 incandescent light dynamo will be bought soon.

Worcester, Mass.—A three-year contract has been made for lighting the streets with 2,000 C. P. lamps at 40 cts. each per night. The former price was 55 cts.

Satilla, Ga.—A 130 H. P. boiler and engine and a 700 incandescent light dynamo will be added to the plant at the Satilla Mfg. Co.

Evansville, Ind.—The Gas & Light Co. will add to their plant electric light apparatus costing $100,000.

Willamette, Ore.—The Falls Electric Light Co. will increase its plant by a 100 arc light and three 1,500 incandescent light dynamos.

Electric Power Transmission.—Falmouth Me.—The S. D. Warren Paper Mills have thrown a dam across the Presumpscot River, 1.25 miles from their works, and will employ the water power so gained for generating electricity. This will be carried to the mills by conductors, where it will drive five 80 H. P. motors. The apparatus will be furnished by the Mather Electric Co., of Manchester, Conn.

New Light Companies have been incorporated as follows: Binghamton, N. Y., Electric Light & Power Co.; incorporators G. J. Morse, G. W. Dunn, G. F. O'Neil; capital, $200,000. Camden, N. J., Accumulator Co.; incorporators G. R. Webb, W. W. Tingley, J. J. Wilkins; capital, $5,000,000. Rahway, N. J., Electric Light & Power Co., incorporators, J. R. Simonson, W. C. Bryant, W. Payer; capital, $50,000. Harrisburg, Pa., Faraday Heat, Power & Light Co.; capital, $30,000. Mineral Point, Ill., Electric Light Co.; capital, $10,000. Grand Forks, Minn., Water, Light & Power Co.; capital, $100,000. Independance, Iowa, Electric Light Co.; capital, $30,000. Fort Worth, Tex., Citizens Electric Light & Power Co.; incorporators, H. Wells, H. Schulze, T. Lewis; capital, $20,000. Ogden, Utah, Citizens' Electric Light Co.; incorporators, F. J. Kiesel, H. W. Smith, W. Schausenbach; capital, $30,000.

CONTRACTING.

Streets.—Brooklyn, N. Y.—Recent bids for granite pavement ran from $2.39 to $2.50 per sq. yd.

New York, N. Y.—M. Baird will pave Broadway from the Battery to Thirty-second St. The contract, which is for $250,000, calls for granite blocks laid as on Fifth Ave.

Amsterdam, N. Y., has given J. C. Miller the contract for supplying brick pavement on a concrete foundation at $2.49½ per sq. yd.

Gloversville, N. Y.—S. C. Ferguson will lay cedar blocks on a sand foundation at $1.40 per sq. yd.

Martin's Ferry, O., has awarded contracts for brick paving at $1.02 to $1.10 per sq. yd.

Columbus, O.—Recent prices for Hayden block paving were $2.03 per sq. yd. with tar filling, or $1.96 with grouting.

Detroit, Mich.—Prices for brick paving have averaged $2.40 a sq. yd., and for cedar blocks on concrete foundation $1.80 a sq. yd.

San Francisco, Cal.—Small contracts for bituminous rock pavement have been let at 30½ cts. per sq. ft.

Sewers.—Lonsdale, R. I.—The sewerage system will be put in by F. E. Shaw whose bids were: Furnishing and

laying vitrified pipe: 4 in. diam., 35 cts.; 5 in., 45 cts.; 6 in., 55 cts.; 8 in., 65 cts.; 10 in., 85 cts. Manholes, $45.

Brooklyn, N. Y.—Anderson & Barr have the contract for section 2 of the Green Ave. sewer. Their bid was $556,000.

Genesco, N. Y., has awarded a $15,900 contract to W. A. Green, of Buffalo.

Toronto, Ont.—Contracts amounting to $47,168 have been granted to W. Cathro.

Grading.—St. Paul, Minn.—Dale & Baumgardner have received a $40,000 contract.

Kansas City, Mo. –11,000 cu. yds. embankment and 8,900 cu. yds. excavation have been let at an average price of 12 cts. per cu. yd.

South Omaha, Neb.—300,000 cu. yds. of earth excavation have been awarded to Stephenson & Williams at $50,000.

Portland, Ore.—800,000 cu. yds. of earth will be used in preparing the foundations for the Union depot, it being necessary to fill a small pond. The work will be done by the Bowers Dredging Co. of Tacoma, whose bid was $225,000.

Street Sweeping.—Washington, D. C.—Recent prices were 29 cts. per 1,000 sq. yds. for paved and 27 cts. per 1,000 sq. yds. for unpaved streets.

Rock.—Galveston, Tex.—A. M. Shannon & Co., will furnish the 30,000 tons of rock filling mentioned in our issue of May 17, at $2.80 per ton.

Cast Iron Pipe.—Washington, D. C.—Lowest bids were $29.80 a ton for 6-in., $32.80 for 3-in.; 2.5 cts. a pound for 75,000 lbs. of special castings.

Gas Lighting.—Yonkers, N. Y.—The Gas Co. offers to supply 4-ft. burners at $21 per burner per year, on a 1-year, $20.50 on a 3-year and $20 on a 5-year contract. The prices for 3-ft. burners are $16.50, $16 and $15.50, respectively.

Dredging.—On the Hudson River, between Cuyler's and Bogart's Lights.—P. J. Brummelkamp, of Syracuse has the contract at 10 cts. per cu. yd., and E. M. Payne, of Albany, for work near the New Baltimore Light, at 10.9 cts. per cu. yd.

Foundations.—Duluth, Minn.—For a drawbridge over the ship canal. Sooysmith & Co., of New York, bid $140,071 and Chas. Stone, of St. Paul, $101,483.

Wire Cable.—Wilmington, Del.—The Cobb Vulcanite Wire Co. have taken a contract for 30 miles of 1-in. electric cable at $607.02 a mile.

Iron Girders.—Washington, D. C.—The following bids for the material for the new Congressional Library building have been opened:

Bidders.	Riveted trussed girders. Per lb.	Riveted plate girders. Per lb.	Connected beams. Per lb.
A. & P. Roberts	3.55	3.55	3.55
Dearborn Foundry Co	3.65	3.3	3.8
N. J. Steel & Iron Co	3.31	3.23	3.45
Pottsville Iron & Steel Co.	3.15	3.15	3.32
Carnegie, Phipps & Co	3.45	3.12	3.45
King Iron Bridge Co	3.25	3.25	....
Phœnix Iron Co	3.15	3.15	3.45
J. M. Cornell	3.9	3.4	3.4

The contract has been given to the Phœnix Iron Co Bids for rolled iron beams were opened as follows:

Bidders.	Per lb.	
A. & P. Roberts	3.45	
J. H. Cornell	3.39	successful bidder.
Pottsville Iron & Steel Co	3.43	
N. J. Steel & Iron Co	3.42	
	3.45	bevelled ends.
Carnegie, Phipps & Co	3.15	square ends.
	2.25	angles.
	3.45	beveled ends.
Phœnix Iron Co	3.15	square ends.
	2.05	angles.

PROPOSALS OPEN.

Sewers.—A. L. Lincoln, Jr., Brookline, Mass., July 14; 10, 15 and 20 in. pipe sewers, E. M. Bigelow, Pittsburg, Pa., July 17; 4,000 ft. 4 ft. storm sewer, W. C. Jemison, Tuskaloosa, Ala., July 15; complete system, W. L. DeLaney, Key West, Fla., Sept. 1; G. C. Force, Cleveland, O., July 24; 17,300 ft. 18 in. outfall sewer, H. S. Jones, Marion, O., July 18; 1,500 ft. 15 in., 1,200 ft. 12 in., 600 ft. 8 in. pipe sewer, Mayor of Dallas, Tex.; R. L. Gorman, St. Paul, Minn., July 14.

Paving.—Granite, J. J. Adams, Brooklyn, N. Y., July 18; vitrified brick on broken stone, H. Homeyer, North Tonawanda, N. Y., July 14; 18,000 sq. yds. vitrified brick on 9 ins. of gravel, and 5,200 ft. curbing, R. D. Stuart, Carbondale, Pa., July 25; Medina sandstone, C. G. Force, Cleveland, O., July 24.

Sidewalks.—Cement, W. C. West, Jacksonville, Fla., July 18; artificial stone and brick, G. Burnet, St. Louis, Mo., July 15.

Railroad Work.—About 35 miles of grading, clearing and grubbing, Georgia & Alabama Construction Co., Cordele, Ga.

Three million cu. yds. excavation and embankment; 2,500,000 ft. B. M. timbering, 150,000 ft. piling, 250,000 cross ties, 1,500 acres clearing in Western Louisiana. H. Forrest & Co., Columbus, La.

Dredging.—44,500 cu. yds. on July 16 and 87,000 cu. yds. on July 23. Dock Dep't., New York, N. Y. At League Island Navy Yard, Pa. N. H. Farquhar, Navy Dep't., Washington, D. C., July 19. H. S. Jackson & Co., Nashville, Tenn.

Breakwater.—Rebuilding, U. S. Engineer Office, Oswego, N. Y., July 17.

Lift Lock on the Rapide Plat canal. A. P. Bradley, Ottawa, July 23.

Bridge.—Federal St. bridge. W. Jackson, Boston, Mass., July 21.

Bridge Approaches.—J. A. M'Connell, Roanoke, Va., Aug. 4.

Piers —Three of wood. Dock Dep't., New York city, July 16 and 18.

Buildings.—Armory at Poughkeepsie. Gen. Porter, State Capital, Albany, N. Y., July 16. Additions to Territorial Insane Asylum, estimated cost, $110,000. R. Kletting, Salt Lake City, Utah. Fifty thousand dollar chemical laboratory and $30,000 Y. M. C. A. hall at Iowa State University, Iowa City. City buildings estimated at $100,000 and $150,000 at Fairfield and Red Oak, Ia., respectively.

Development of Water Power.—Albert Carney, Sault Ste. Marie, Ont. July 21.

Iron Work for U. S. court house and post office at Pittsburgh, Pa. J. H. Windrin, Treasury Dept., Washington, D. C. July 28.

Water Works consisting of masonry dam and 45 miles cast iron mains. J. K. Reshel, Hughesville, Pa.

Pumping Engines.—E. S. Foster, St. Louis, Mo. July 15.

Tunnel.—About 3,000 yards. McCormick & O'Meara, St. Louis, Mo. Sept. 1.

Cast Iron Water Pipe.—About 550 tons of 10, 8 and 6-in. J. Armstroug, Owen Sound, Ont. July 14.

Drinking Fountains.—R. J. Leigh, West Toronto, Ont. July 16.

Stone Crushers and Steam Drills.—L. S. Gould, Melrose, Mass. July 15.

Tube Plant for Pneumatic Ry. Co., 607 Chestnut St., Philadelphia, Pa.

Steam Fog Signal with boilers and machinery complete. Maj. L. C. Overman, Cleveland, O. July 15.

Boiler Plant for work-house. W. C. Muller, Cincinnati, O., July 26.

Laying Water Pipe.—T. J. Neville, Rochester, N. Y., July 21.

MANUFACTURING AND TECHNICAL.

Cars.—The Mt. Vernon, Ill., Car Mfg. Co. has closed a contract with the Louisville & Nashville R. R. for 200 double hopper bottom cars.

The Jackson & Sharp Co., Wilmington, Del., have delivered 3 passenger and 3 combination cars to the Lehigh Valley R. R. and are now building 6 passenger cars for the Richmond & Danville and 2 for the Cincinnati, Wabash & Michigan lines.

The West Virginia Central Ry. will soon order 300 freight cars, the Huntington & Broad Top R. R. 300 gondola cars, the New York, Lake Erie & Western R. R. 50 passenger cars, the New York, New Haven & Hartford R. R. 50 passenger cars, the Pennsylvania, Poughkeepsie & Boston R. R. 500 freight cars.

The Erie Car Works are building 1,000 freight cars for the New York & New England R. R.

The Union Pacific Ry. has received 7 drawing room cars from the Pullman Co., which are said to be the finest ever built.

The Wason Car Co., Springfield, Mass., are building 50 cars for the New York Elevated Ry., 12 for the Housatonic R. R. and 10 for a Chilian line.

The John Stephenson Co., New York City, has orders on hand from the Coney Island & Brooklyn R. R., the Georgetown & Tenallytown R. R. and a large number of street railway companies.

The Indianapolis Car Works have been asked to bid on 1,400 box cars for the Atchison, Topeka & Santa Fe R. R.

The Iron Car Co. has been reorganized and placed under the financial management of a syndicate headed by Brown Bros.

Car Wheels.—The Fowler Rolled Steel Car Wheel Works have orders for 11,000 wheels.

The Steel Truss Car Wheel Co. is building a shop, 60 by 160 ft., at Edwardsville, Ill.

Locomotives.—The Illinois Central R. R. will soon order 30 engines.

The Baldwin Works are at work on 8 freight engines for the Cincinnati, New Orleans & Texas Pacific Ry., and 40 engines for the New York Elevated lines.

The Marietta & North Georgia R. R. has received two 60-ton freight engines from the Rhode Island Locomotive Works.

Car Works will be built by the Georgia Central R. R. at North Binghamton, Ala. About 1,000 men will be employed there.

The Norfolk & Western R. R. Co. will erect machine shops at Lambert's Point, near Norfolk, Va.

The Chicago, St. Paul, Minneapolis & Omaha Ry. will build extensive shops at Hudson, Wis.

The Georgia Pacific Ry. will build shops to employ about 2,000 hands at Birmingham, Ala.

Filters.—The Morison-Allen Co., New York City, has lately built the following plants: Saylesville, R. I., 3,000,000 galls. daily capacity; Am. Wood Paper Co., Manayunk, Pa., 2,000,000 galls.; Albemarle Paper Co., Richmond, Va., 1,000,000 galls.; Franklin Sugar Refining Co., Philadelphia, Pa., 500,000 galls.; Trenton Iron Co., Trenton, N. J., 500,000 galls.; Diamond Ice Co., Wilmington, Del., 150,000 galls.; Cranston's Hotel, West Point, N. Y., 200,000 galls.

Pipe Works will be built at Sheffield, Ala., by H. B. Tompkins. They will cost $100,000 and have a weekly output of 150 tons.

Iron and Steel Works.—The Northwestern Malleable Iron Co., Milwaukee, Wis., will build a new foundry 70 × 150 ft., by which its capacity will be increased to 6,000 tons a year.

The West Superior, Wis., Iron & Steel Co. proposes to build Bessemer works and a rolling mill.

The Milwaukee Bridge & Iron Co. contemplates erecting a new main building 600 × 100 ft. at a cost of $175,000.

The Colorado Coal & Iron Co., Pueblo, Col., are running night and day. Their present output is 250 tons of rails and 240 tons of pig daily. A pipe foundry is building which will turn out 60 tons a day.

The Coos Bay Iron Co., Kirkland, Ore., will begin work at once on their plant, which is expected to cost $1,000,000.

The Shiffler Bridge Co., Pittsburg, Pa., will build the 300 × 150 ft. finishing mill for the Illinois Steel Co.

The Keystone Bridge Co. has shipped to San Francisco a plate girder which is stated to be the largest in the country, being 103 ft. long and weighing 70 tons.

The Smith & Vaile Co. has recently sent a steam pumping plant of 2,000,000 galls. daily capacity to the Anderson, S. C., water-works, two plants of 1,000,000 galls. capacity each for the coal shafts at Scranton, Pa., and 1,000,000-gall. plant to Long Island City, N. Y., for fire service.

Creosoting Works employing 200 men will be built near Houston, Tex., by the Southern Pacific Co.

A Grain Elevator will be built at Weehawken, N. J., by the New York, West Shore & Buffalo Ry., at a cost of $1,500,000.

The Urie Mfg. Co., Kansas City, has received an order for two powerful dredges for use near Corpus Christi, Tex.

The Brush Electrical Engineering Co. have supplied all the electric lights for use in the Edinburgh Exhibition. There are in all 365 arc lamps of 2,000 c. p. each.

The Thomson-Houston Co. are building a new factory at Lynn, Mass., for manufacturing the mining machinery invented by C. J. Vandepoele.

An 8-Wheel Electric Car has been successfully tested on the West End Ry. at Boston, Mass. It is 28 ft. long, and run by a 15 H. P. Thomson-Houston motor.

The Westinghouse Electric & Manufacturing Co. with a capital stock of $10,000,000 has succeeded the Westinghouse Electric Co., the officers of the new being those of the old company. The change is believed to be preparatory to a union of Westinghouse and Pullman interests for building electric railway.

New Companies.—Compania Metallurgia Mexicana incorporated at Newark, N. J., by R. R. McCarter, R. S. Towne, A. F. Higgins and others, with a capital stock of $400,000. The Norristown, Pa., Rolled Steel Co., incorporated by S. D. Hawley, L. K. Passmore, L. T. Brook and others, with a capital stock of $200,000. The Automatic Car Step Co., Grand Rapids, Wis., capital stock, $25,000. National Railway Electric Signal Co., Des Moines, Ia., incorporated by W. J. Ham, D. M. Fike, S. L. Fuller, and W. P. Graham, with a capital stock of $1,500,000. The Norwood Car Replacer Co., incorporated at Baltimore, Md., by W. C. Codd, H. C. Thomas and J. E. Norwood, with a capital stock of $300,000, to manufacture the Norwood Car Replacer, already illustrated and described in our columns.

Metal Market Prices.—***Rails***—New York: $31 to $31.50; for old iron rails, $24.50 to $25. Chicago: $33.50; old rails, $23 for iron, $18.50 to $21.50 for steel. Pittsburg: old rails, $27.50 to $28.50, for iron.

Foundry Pig-iron.—Chicago: $13.50 to $17. Pittsburg, $14.50 to $18. New York: $16 to $18.50.

Track Materials.—New York: steel angle bars, 1.8 to 1.9 cts.; spikes, $2.05 to $2.10; track bolts, 2.8 to 3 cts. with square, and 3.10 to 3.15 cts. with hexagon nuts. Pittsburg: splice bars, 1.95 to 2 cts. for iron; spikes, 2.15 cts.; track bolts, 2.85 with square, and 3 cts. with hexagon nuts. Chicago: splice bars, 2.25 cts. for steel, and 2 to 2.05 cts. for iron; spikes, $2; track bolts, 3 cts., with hexagon nuts.

Pipe.—Cast-iron, $27 to $30 per ton. Wrought iron, discounts as follows: 47½ and 40 per cent. on black and galvanized butt-welded; 60 and 47½ on black and galvanized lap-welded. Casing, 50 per cent.

Lead.—New York, 4.35 cts.; Chicago, 4.4 cts.

Structural Material.—Pittsburg: angles, 2.15 to 2.2 cts.; tees, 2.75 to 2.8 cts.; beams and channels, 3.10 cts.; sheared steel bridge plates, 2.65 to 2.75 cts.; universal mill plates, 2.3 to 2.4 cts.; refined bars, 1.9 to 2 cts.; steel plates, 4.25 to 4.75 cts. for fire box; 3.15 to 3.20 cts. for flange; 3 cts. for shell, 2.75 cts. for tank. New York: beams, 3.10 cts., plates, 2.15 to 2.20 cts.; angles, 2.25 cts.; tees, 2.5 to 2.6 cts.; channels, 3.1 cts. Chicago: angle, 2.3 cts.; tees, 2.65 cts.; beams, 3.2 cts.; universal plates, 2.45 to 2.55 cts.